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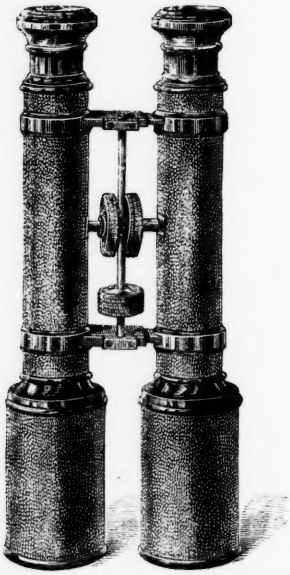

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THE MONTHLY

JOURNAL OF SCIENCE.

AUGUST, 1879.

I. ENGLAND'S INTELLECTUAL POSITION.

THE Literary and Philosophical Society of one of the most important towns in England recently memorialised the Privy Council against the recognition of Owens College as a University. The petitioners professed to be alarmed at "the serious risks to which an undue increase in the number of degree-giving universities would expose the whole system of English education."

This plea surely insinuates that the English system of education, if not absolutely perfect, is to be regarded as superior to that of other nations, and that it could scarcely be modified except for the worse. Reflecting on the opinion thus conveyed, it seemed to us not useless to inquire what are the peculiarities of English education as compared with the systems established or aimed at amongst our neighbours and rivals, and what are the fruits of such distinctive peculiarites as manifested by England's share in the advance of culture. The foremost characteristic of English higher education—for that alone can be meant—is its monastic character. In monarchic Germany, as in republican America, a college consists merely of class-rooms, lecture-halls, libraries, laboratories, and other localities needful for research and study. The students live in lodgings in the town according to their tastes and means. The professors reside in private houses, and, so far from being forbidden to engage in any literary work without special permission, the more they create a reputation for themselves by the publication of their observations and discoveries the more honour they are con-

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sidered to reflect upon the institution. With us all this is different; in a college of the normal English type the professors and students are obliged to "live in," like the hands of a modern gigantic drapery warehouse. Celibacy is the rule, by way we suppose of inducing men of high reputation to feel contented, and over the whole convent rules a Father Abbot, empowered, of his own motion, to appoint and dismiss officials irrespective of their standing, and to interfere with the details of all departments, however slight may be his qualifications to do so with benefit.

Worse still remains; the most eminent professor, instead of devoting his leisure to research, is expected to undertake the degraded and degrading task of maintaining "good order and discipline among the students." In other words, he is called upon, figuratively speaking, to assume the cocked hat and red waistcoat of Bumble! Those who are so clamorous for the maintenance of "discipline" forget that the necessity is entirely of their own creation. Enforce "residence;" shut up a number of young men together in flat violation of the order of Nature; compel the thoughtful and the studious to associate, will they nil they, with the idle, the reckless, and the profligate; give the bully a free choice of victims—and the duties of the beadle must devolve upon some one. But disperse students through the town or neighbourhood, and they will no more require any special officers for the enforcement of "good order" than would an equal number of bank clerks or young men engaged in the Civil Service.

Such, then, is the foremost peculiarity of the "system of English education"—a distinct "survival" from the days of ignorance which surely deserves exposure to something more than a mere "serious risk" of overthrow.

The second characteristic of our English colleges, as compared with their foreign rivals, is more deeply seated, and will prove much less easy to reform. It lies in the very character of the teaching given. The German professor, both by precept and example, seeks to qualify his students to add something to the existing total of human knowledge. He trains them for research, for discovery; he judges of their proficiency by the power they display of dealing with unsolved questions,—with those problems in which every branch of Science abounds. He makes them the partakers of his own investigations. The highest honours are earned *rebus gestis*.

According to our English system all this is well-nigh reversed. Men study, as Prof. Huxley well expressed it,

not to "know" but to "pass." He who can make himself most fully acquainted with the works of others bears the bell, whether he is capable of conceiving an original thought and of carrying out a train of research or not. We are consequently rich in "all-round" men, who can talk with considerable fluency on every known Science, but who are neither able nor willing to extend the boundaries of any.

If we point out this sad defect in the working of our educational system we are often told, by way of excuse or justification, that English Universities are not investigational but "tuitional,"—mistuitional rather,—and that if we want seats of research we may found and endow them ourselves. But suppose we act on this kind permission, and that we attempt to secure for the institutions we have created the power of testing and recognising merit, then there are found men not ashamed to petition Government to withhold from us the power of granting degrees. We have sometimes advocated the endowment of research. Alas! we should feel but too happy if no positive hindrances were placed in its way—if there were within the four seas of Britain even one college where original work was the sole passport to distinction.

Let us not, however, condemn this wonderful "English system of education" on mere theoretical grounds, but let us examine its practical working. Are we holding our own in comparison with rival nations? Are we giving or mainly receiving light? The answer is not hard to find. Look, for instance, at chemistry. According to a summary compiled by Prof. Frankland, of 1273 memoirs embodying the results of original research, published in 1866, the United Kingdom contributed only 127, or about one-tenth; Germany producing 777, or more than half of the grand total. Worse still remains: of the papers with which Britain is here credited no inconsiderable portion is due to Germans resident in this country. We have no reason to believe that in the dozen years that have sped since this return was made the relative position of Great Britain has much improved.

But let us turn to another sphere in which we have far greater opportunities than any other nation—perhaps than all other nations combined. We refer to the exploration—geological, zoological, and botanical—of the less-known regions of the globe. It is self-evident that, with our vast colonial Empire and our ubiquitous commerce, such countries ought to be first and foremost examined by Englishmen,—that their description should be given through English pub-

lications,—and that their productions should be displayed in our museums and botanical gardens. Have we, then, even in this department, such a vast superiority as might reasonably be expected? Without the slightest wish to overlook the splendid services rendered to Science by Darwin, Wallace, Bates, and Belt, we fear we cannot reply in the affirmative. Let us take the case of New Guinea, an island of whose magnificent fauna Mr. Wallace gave us, sixteen years ago, so tempting a vision. Let us consider that it is merely separated by an arm of the sea from important thriving and energetic provinces of the British Empire, and we should naturally expect that English speaking travellers would take up and complete the task. Not so; Dr. Maclay, the Russian, and Prof. D'Albertus, the Italian, have stepped in before us. Turn even to the Fiji Islands; we have annexed them, but their thorough scientific examination has been allowed to fall into the hands of foreigners, who make better use of their scanty facilities than we do of our incomparable opportunities. In Africa the case is but too similar. Travellers from Germany,—we need only mention Dr. Schweinfurth,—from Belgium, France, Italy, Portugal, are at work in all directions, and are gathering rich spoils of discovery. We are, meantime, piously hoping to do a large business in the interior when the Zulus are disposed of. Let us beware lest we are merely conquering a market for others.

There are yet other tests to which our educational system can be submitted. Do our colleges attract students from foreign countries? With the exception, mainly, of a few Japanese our seats of learning are not frequented by strangers. Numbers of American young men go abroad to complete their studies; but they repair not to England, but to Germany. The same rule holds good with various other nations. What they require is not to be found amongst us.

Again, it may be asked whether we send out professors of the sciences to foreign nations, civilised or semi-barbarous? Are the universities, the libraries, the museums of the world to any marked extent in the hands of Englishmen? He who cannot at once answer this question with a decided negative must have spent his days in dream-land. We believe that over the whole European continent, as well as in the United States, there is not a single professorial chair occupied by an Englishman. Such posts, if not filled by natives of their respective countries, seem to fall, as a matter of course, to Germans. Science in Russia, for instance,

has undergone a development which thirty years ago would have been pronounced simply impossible. But it is purely of German creation. Germans have trained and fostered speculative research in the Universities of Kazan and Perm, just as they have guided applied science in the print-works of Moscow and the foundries of Tula. So successfully has this been effected that Kazan and Perm contribute more original investigations than any British University, and that at the late Paris Exhibition Moscow outstripped Manchester and Glasgow in the purity and brightness of its alizarin-red grounds.

Turning from Russia to a country of far older civilisation, where intellectual pursuits of all kinds have undergone a striking revival, we find professorships at Turin and Rome held by distinguished Germans. In the United States, though there exists a great and increasing body of scientific men of American origin, Germany is playing her part of general instruction. Even in the quasi-civilised States of South America the same facts are to be recognised. Whatever scientific activity exists is due to Germans, and is placed under their guidance.

We see thus that over a very great part of the civilised world there is a double movement in progress; students are flocking from all ends of the earth to German seats of learning, and professors are going forth to all ends of the earth as apostles of culture. On the contrary, England is the focus of no such centrifugal and centripetal movement. As a natural consequence German literature, German ideas, German habits of thought are spreading everywhere. Nor is this, as might perhaps seem at first sight, a matter of barren honour. The German professor—settled, say, in South America or in Japan—naturally uses his influence on behalf of the German manufacturer and the German merchant. If a new branch of industry is to be introduced German engineers, or chemists, and German workmen are sent for, as is now the case with a woollen manufactory in China, which is being established on European principles. Nay, it may even be that our political weight is suffering from what foreigners cannot but regard as our inferiority and ignorance.

Such, then, is the state of affairs outside the boundaries of the British Empire. How is it within? To a very great extent, both in the home kingdoms and the colonies, we find ourselves compelled to import that intellectual eminence which we refuse to cultivate in our midst. Foreigners oc-

cupy professorial chairs in our colleges; they fill the posts of botanists and geologists to our colonial governments; they hold high positions in the respective staffs of the British Museum, of the Geological Survey of India, and of our exploring expeditions. If we pass to the regions of Applied Science we find aliens in increasing numbers managing our most important manufacturing establishments. In the year 1858 there was one foreign chemist employed in the great alkali district of south-western Lancashire. How many are there now? Nay, Dr. Reimann does not scruple to boast, in the "Faerber-Zeitung," that English manufacturers owe whatever eminence they may claim not to Englishmen, but to Germans. Making all due allowance for exaggeration, there is too much reason to own that we as a nation are sinking into the position of mere "hewers of wood and drawers of water," whilst every function requiring disciplined intelligence—save and except the miserable task of speech-making—is passing into the hands of strangers.

Now we submit that it is not in virtue of any inbred deficiency if the countrymen of Newton, of Faraday, and of a few living biologists and physicists, are outstripped in the pursuits of Science by any nation upon earth. If we fall short, as the picture we have just hastily sketched so plainly shows, it is due to that deplorable "English system of education" to which we cling with an attachment so fanatical. Are we still to go on passing examinations whilst other nations are effecting organic syntheses? Are we to accept our senior wranglers and double first-men as an equivalent for their discoverers and inventors? If so, all other reforms and "movements" notwithstanding, our abdication of the rank we once held is sealed and signed.

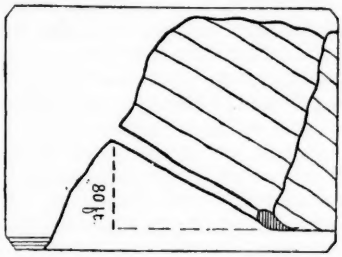
II. PARADOXICAL PHENOMENA IN ICE-CAVES.*

By N. M. Lowe.

IN the "Scientific American" for March 29th last there appeared a letter from Mansfield, Ohio, inquiring as to the cause of the phenomena in an ice cave which is to be found in Decorah, Iowa, and for which there appears

* Read before the Boston Scientific Society, April 9, 1879.

to have been as yet no cause assigned. A description of this cave is given in the same letter, of which description, so nearly as is possible, the accompanying illustration is a fair representation, as regards the main features of the case.



There may be a few differences as regards the details of the cave, but so nearly as can be judged from the written description the drawing presents the elements necessary to the peculiarities of the cave. In the figure the cave will be seen represented as at the bottom of an inclined passage, the inclination being that noted in the description, and the dimensions and other particulars being as nearly as possible to the proper scale. The crevice mentioned in the description may be imagined as a fault, which extends from the top of the cave to the top of the bluff, through which crevice mingled air and water finds its way to the cave.

In regard to the mingling of air with a stream of descending water, a quotation from the pamphlet of Mr. Frizzel, on the subject of the compression of air by such streams, would not be entirely out of order. On this subject he says—"It is a matter of common observation that bubbles of air rise in still water with a very moderate velocity. The velocity depends somewhat on the size of the bubbles. Bubbles, such as issue from an orifice one-eighth or one-tenth of an inch in diameter, rise from a depth of 50 feet in about fifty seconds, moving rather less than 1 foot per second near the bottom, and rather more than that near the surface. It is plain that a bubble of air drawn into water that has a downward motion of more than 1 foot per second will be carried down and subjected, in its descent, to a continually increasing pressure."

Considering, then, the description and the facts above quoted, it would not be unfair to assume that there would be a possible compression of air contained in the water, on its liberation in the cave, of about 80 lbs. to the square inch.

This assumption is supported by the fact that, from the description, the mouth of the cave would be at least 80 feet above the level of the river, and it may be inferred that as no special mention is made of the position of the entrance, save that it is in the side of a bluff, the hill may be considered as extending above the mouth of the cave to at least the distance of the latter from the river.

The phenomenon, then, of ice being found there in the summer can be referred, I think, to the theory of the liberation of compressed air brought down from a considerable height by a stream of water falling or flowing through a natural conduit or fissure in the rock, embodying the principle of the ancient and well-known *tromp* used in the Catiline forge, and still in use in Corsica, Sardinia, Savoy, and many other places.

It is only necessary to imagine such imperfection in the conduit or fissure at the initial point, which is supposed to be on the top of the bluff, or far up the mountain's side, as would admit air to come in contact with the water after it had attained a velocity of more than 1 foot a second. When the air has reached the bottom, and is liberated in the cave, it will be from a pressure equal to the height of the column of water, and it will have lost by *convection*, in the mass through which the conduit passes, the heat *due to its compression;* and on being liberated it will immediately absorb, from the air and the water in the cave, the heat which it has lost in its downward passage.

"The most remarkable fact," that the cave freezes only in summer, and as the cold of actual winter comes on the ice in the cave gradually melts and disappears, is caused, I will venture to state as an opinion, by the gradual freezing of the surface at the top of the bluff, or the source of the air, to a considerable depth, thus sealing up the aperture through which the air entered the conduit.

Sir Roderick Murchison described a similar ice cave at Lletski, Russia, but gave no explanation as to the phenomena.

Ice wells are to be found at the foot of Mount Mansfield, in Vermont, and are really incipient caves, without depth enough to be clear of ice in winter, from the fact that the external winter temperature reaches the bottom or source of the summer ice.—*Science Observer.*

III. PAIN AND THE WEATHER.

IN his Paper on the "Relation of Neuralgic Pain to Storms and the Earth's Magnetism," read before the National Academy of Sciences, Prof. S. Weir Mitchell reported the following observations:—

Capt. Catlin, U.S. Army, lost a leg during the war, and since that time has suffered from traumatic neuralgia, sometimes in the heel, but more frequently in the toes, of the foot. He has carefully noted the effects produced on himself by changes of the weather. Dr. Mitchell's own studies in this case, as he says, "would never have proved successful had it not been for the unusual ability, interest in the task, and perseverance of the accomplished gentleman who has obliged me by making his own torments useful in the solution of the question of how far weather effects the production of certain kinds of pain." The hourly observations cover a period of five years. For the first quarters of these five years there were 2471 hours of pain; for the second quarters, 2102 hours; for the third quarters, 2056 hours; and for the last quarters, 2221 hours. The best yield of pain is in January, February, and March, and the poorest in the third quarters—July, August, and September. During these five years, while the sun was south of the equator, there were 4692 hours of pain, against 4158 hours while it was north of the equator; and the greatest amount of pain was in the quarters beginning with the winter solstice, and the least was in those beginning with the summer solstice. The average duration of the attacks for the first quarters was 22 hours, and for the third quarters only 17·9 hours.

By taking the four years ending January 1, 1879, it is found that of the 537 storms charted by the Signal Bureau, 298 belong to the two winter quarters, against 239 for the summer quarters. Hence we have the ratio of the number of storms of the winter quarters and summer quarters corresponding to the ratio of the amounts of neuralgia for these respective periods, and the ratio of average duration of each attack for the same time corresponds closely with the ratio of the respective total amounts of neuralgia for the same periods. The average distance of the storm centre at the beginning of the neuralgia attacks was 680 miles. Storms coming from the Pacific Coast are felt farthest off, "very soon after, or as they are crossing the Rocky Mountains," while storms along the Atlantic Coast are associated

with milder forms of neuralgia, and are not felt until the storm centre is nearer. Rain is not essential in the production of neuralgia.

It was found that the severest neuralgic attacks of the year were those accompanying the first snows of November and December. One of the most interesting and valuable results of this series of observations is thus stated :—"Every storm, as it sweeps across the continent, consists of a vast rain area, at the centre of which is a moving space of greatest barometric depression, known as the storm centre, along which the storm moves like a bead on a thread. The rain usually precedes this by 550 to 600 miles, but before and around the rain lies a belt which may be called the neuralgic margin of the storm, and which precedes the rain about 150 miles. This fact is very deceptive, because the sufferer may be on the far edge of the storm basin of barometric depression, and see nothing of the rain, yet have pain due to the storm.—*Kansas City Review of Science and Industry.*

IV. A METHOD OF PREVENTING THE TOO RAPID COMBUSTION OF THE CARBONS IN THE ELECTRIC LAMP.

By H. W. Wiley.

In using the electric light for projections two chief points are to be considered, viz., 1st, brilliancy of illumination, and 2nd, steadiness of the light. When the source of electricity is sufficient the first of these ends is easily obtained. The second, however, is not so easy of accomplishment. The chief difficulty in the way of securing steadiness is found in the carbons themselves. Some carbons, and I find these to be the most common, burn away so rapidly that, where no mechanism is present to produce alternating currents, the electric arc is constantly passing out of the focus. Often, too, I have found that when the current is quite strong with the softer carbons, the arc would extend itself momentarily between points as far as a

centimetre from the end of the carbons. At other times it would revolve about the electrodes something like a spiral flame in a pyrotechnic display. This leaping and dancing of the arc is, of course, fatal to its employment for projection.

In order, if possible to remedy these defects in a lantern which I have in almost daily use, I made the following experiments:—I first took the specific gravity of three specimens of carbon, obtained from different dealers, one in France and two in America. The specific gravity of the French carbon was 1·85; of No. 1, American, 1·53; of No. 2, American, 1·55. The French carbon is hard, of a grayish black colour. The American carbon is soft, easily broken up, and has no sign of a metallic lustre. The light from the French carbon is quite steady, and displays very little of that tendency to flicker so troublesome in the American varieties.

A positive French carbon, which had been used for several hours, until consumed nearly to the lamp, burned away at the point, but otherwise retained its original shape. This carbon was used without any previous preparation.

A soft carbon, however, of the same size as the preceding, became red-hot to a distance of 4 to 6 centimetres from the end, and rapidly wasted away; after being in use for half an hour it was reduced to a slender, tapering form.

I first tried the plan so well known in France, but so seldom tried here, of coating the carbons with a film of copper. The precipitation of the copper should take place slowly, and with a current so regulated in quantity and intensity as to produce no spongy deposits. When the soft carbons were thus prepared they worked beautifully for a short time. The light was brilliant and steady, while any green tint imparted to it by the volatilised copper produced no effect whatever prejudicial to the purpose in view. But as the carbons, little by little, became heated, the copper film oxidised, and after half an hour the carbon was again reduced to the slender form above described.

I next tried the expedient of setting a copper wire, 0·4 m.m. in diameter, into the centre of the carbons. With a thin saw I cut a longitudinal groove to the centre of the carbon, and after inserting the wire fixed it in place by filling the groove with plaster. The upper end of the wire was left projecting so that it could be brought into actual contact with the clamp. I hoped from this contrivance to hold the origin of the arc steadily at the end of the carbon, and at the same time, by increasing the conducting power, to pre-

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vent the heating and consequent rapid consumption of the electrode. In placing the carbons in the lamp the grooved sides were turned from the lens. This device proved very successful in securing a steady light, but the carbons were heated to their points of insertion in the holders, and wasted rapidly away. The point, it is true, remained blunt, but the stem of the carbon burned away so rapidly that the experiment must be regarded as unsuccessful.

It was evident from my first experiments with copper-plated carbons, that, if any way could be devised of protecting the copper from oxidation, the copper would prevent the carbon from heating by increasing its conductivity and diminishing the resistance. I accordingly covered the carbons, after copper-plating, with a film of plaster of Paris, about 1 millimetre in thickness. After this had set, the edge of the carbon, which was to be turned towards the condenser, was carefully denuded of its plaster covering, which was also cut away until quite thin on the adjacent surfaces. These precautions were taken so that the plaster might not interfere with the radiation of light in the direction of the condenser. Before use the plaster must be thoroughly and slowly dried. The copper surface at the end of the carbon being uncovered, it is fastened in the holder in the usual way. The carbons prepared in the way described left nothing to be desired. The light was steady, and the carbons burned slowly away. The film of plaster melted gradually as the point was consumed, and thus never interfered with the illumination. The points of both positive and negative carbons remained blunt, and there was no wasting away of the stem. A carbon prepared in this way will last at least ten times as long as one used in the ordinary way. But the chief advantage is found in the comparative steadiness of the light thus secured.

Carbons of the above description work best when well plated. The following numbers give what I regard as a minimum amount of copper to secure satisfactory results. In all the experiments I have tried the carbon has been of the soft American variety, with an average specific gravity of 1·55.

Length of carbon	17·5 c.m.
Each side	1 ,,
Number $\frac{}{\text{c.m.}^2}$ of surface, including ends	72 $\frac{}{\text{c.m.}^2}$
Weight before coppering	21·1615 g.
,, after coppering	24·0410 ,,
,, of copper	2·8795 ,,
,, ,, to each $\frac{}{\text{c.m.}}$	0·0397 ,,

In order to dispense with the use of a reflector I arrange the carbons + above, as described in the "Journal of the Franklin Institute" for May and June, 1878.

The peculiar cup-shaped appearance of the positive carbon helps to concentrate the light on the condenser. It is understood that any lamp in which the carbons are arranged end to end can be used with electrodes prepared as above. Such a lamp can be easily substituted in a lantern made for use with oxy-hydro-lime light. I use constantly such a lamp with one of Edgerton's physical lanterns originally made for the lime light. I am inclined to think a kaolin paste would be better than plaster for coating the carbons. The electric force used in all the experiments has been furnished by the Gramme machine, described in the "Journal of the Franklin Institute" already cited.

The use of projections for illustration in lectures on Chemistry and Physics has become so general that I hope the suggestions in this Paper may prove of some benefit.—*American Journal of Science and Arts.*

V. SEED-BREEDING.

By E. Lewis Sturtevant, M.D., So. Framingham, Mass.

WE sow wheat in order to reap wheat, and rye in order to reap rye, and corn in order to harvest corn; and were the wheat to turn out rye, and the corn-field to yield barley, we should suffer even a greater bewilderment than did the heroes of ancient fable when they became intimate with those enchanters and sorcerers who caused fishes to indulge in conversation and mankind to become changed into beast-like forms. For the world is so subject to law that its recognition on a large scale is part of each man's daily experience; and living amid the triumphs of modern science, even the every-day labourer is educated unconsciously within the sequences of a more and more correct

philosophy, so that in general terms he recognises that as he sows he must reap, and that thorns do not bear figs, nor thistles grapes. In this aspect of the case it would seem to be unreasonable to talk about heredity in plants, because the statement of the fact in general is uncalled for, being universally known and universally recognised as known. Yet we purpose to give a few thoughts on the subject, despite the apparent clearness of the claim that seeds have a heredity inherent in their nature and structure, because we recognise that the *application* of the well-known fact of heredity in these cases has not received a proper attention from the public, and that while the fact may be well apprehended, yet too few are willing to carry reasoning based on the correct premise to a logical and practical conclusion.

We certainly have no reason to believe that there is one law for vegetable and another for animal life; rather, we have firm grounds for asserting that all life is subject to the same laws of Nature, and that apparent differences are to be ascribed but to the individual under observation, being subject to forces under a greater or less antagonism, or from the simplicity or complexity of its structure and functions which render it amenable to one law rather than to another. Thus, to illustrate our proposition, we can say that a plant and an animal are subject to the action of the great natural forces which affect life and its development, such as gravity, heat, light, &c.; yet the application of a stimulus which will produce no apparent movement in the one may excite muscular action in the other; or, to make a more mechanical suggestion, a falling stream of water may serve to move a saw which shall convert a log into boards, or shall act on a more complicated series of machinery to turn a lathe which shall convert the same log into spools, or the irregular gun-stock. In either case the same moving force has acted, but the work accomplished has been modified into different results through the action of another force, the mind of man, which has intervened to produce oppositions, and through the reaction of these varied oppositions has contributed to the concrete effect of the force derived from gravity upon the shaping of the log. Thus, in Nature, we have the *life*, distinguished from mineral matter by the possession of motion, and the power of adding to itself, through the force which this motion implies, from the surrounding world, of matter suited to its own structure and function, and imparting to it of its motion. Once stop this motion, destroy this mysterious force, and the life becomes subject to other conditions, and dissolves its structure, the function being

lost as well, into the matter which is incapable of acting on itself to produce this added power which we call life and organism. We, however, may say that mineral is one phase of matter which is subject to one set of laws and conditions, and that life is this same matter, with added force which renders it subject to an additional set of laws and forces, which are more or less greater or less powerful, according to the complexity of the life upon which they can act. The true view of Nature is, then, according to our view, that laws are continually in action and are universal, and that it is the province of the existent life or matter to use these laws according as the structure and function affect their relations; and that hence the mind of man, which recognises and adapts existing relations to his own benefit, by modifying through law, structure, and function, can arrange relations to other laws, and produce diversity of result.

The law of inertia, which is defined as being that condition of matter by which its existing state is retained, if at rest, rest, if in motion, the continuance of that motion until other forces in action shall produce a change, serves as well for the consideration of the problem of life. A perfect likeness between parent and offspring would presuppose the parents being from all time in a state of *inertia*,—a supposition which nullifies the proposition, as the act of having offspring would be a departure from that state. Yet when we define the science of breeding, and state that "like produces like," we recognise the fallacy of the proposition as applied with exactness to individuals, and modify it immediately by limitations, which if they serve to weaken the statement, yet serve to make it not contradictory to our experience. Rather the law of variation should be the keyword for breeding, although the proposition that "like produces like" as a mental conception is as true and as applicable as is the proposition that *inertia* is a definition of a law of Nature. Like does produce like when every condition is removed which would produce difference, which only can be done as a mental act: a body is considered as continuing in its present state when every condition involving a change is removed by a mental act. Hence the "law of likeness" is of the most importance to that breeder who desires to so modify surroundings as to restrain his animals from being improved in their progeny; and the "law of variation" is deserving of the more attention from that breeder who would desire to improve his animals in their progeny.

We might amplify this proposition to almost any extent

did we deem it desirable to encumber our essay with metaphysics, but we think that the careful reader or hearer will understand us in our statement that progress comes through variation, and not through likeness; that whether we breed the vegetable or the animal, it is the laws of variation which we must study and apply in order to produce progressive results: and that the law of likeness, the "like produces like" of our books, however true as an expression which must be and is followed by numberless limitations, is but of secondary importance to the practical dabbler or expert in the art of breeding, to that much more important law which embraces the variations and fixing of structures and functions which have been obtained. The pendulum swings to the right hand and to the left with a uniform motion. Any pendulum of the same length of rod and same weight of bulb, under given conditions, vibrates through the same arc. This statement may illustrate the breeder's proposition that "like produces like." Yet let any two of us make a pendulum of equal length of rod and weight of bulb at our own homes, and we would find that practically they would not move over the same arc, because we would use rods of different character or diversity, or bulbs of different centres of gravity, or would hang them differently, or would calculate the arc traversed under temperatures which were different. It is only as we understood these causes of variation that it would be possible to produce two pendulums whose oscillations would compare. This may liken the "law of variation" which is the "application law" for breeders, as distinct from the "like produces like," which is a true, yet a "theoretical law," which does not admit of practical application without the use of the "application law" as here defined. Heretofore, the tail has wagged the dog; we do not propose to stop the wag, but to have the dog wag the tail. Unless this point be understood breeding as a science will cease to progress, and, indeed, the triumphs of the art have come from the unconscious application of these facts rather than from the course which theorists have laid down:—"Variation and likeness," not "Likeness and variation." This is the new and correct method for the study of the laws of breeding as practised. Just as cultivated vegetables have in a large degree been removed from the wild vegetation, and their different status been apprehended, must their breeding science leave wild nature, and come to a cultivated application.

These remarks must be understood to have a close and practical bearing on the breeding of seed, for a plant, as

being individually confined to one locality, has a limit placed by its structure and position in respect to its environment which the animal does not have, and is subject to a different order of variation. The animal progeny comes from a distinct act of the father, and the offspring following this act have characteristics determined by this and other limited systems of parentage; but the ovules of the plant receive fertilisation in general from a large number of parentages, and the seed represents, as in animals, both maternal and paternal influences. The litter of a sow are brothers and sisters; the kernels of the corn plant are not necessarily brothers and sisters, but bear the same maternal influences and different paternal influences, and hence have a variation in their growth and seeding which is dependent on a different species of relationship than in the animal. To illustrate these effects we may mention that while in carefully bred cattle the variations in the progeny are seldom, if ever, sufficient to constitute a new variety, yet Colonel Le Conteur relates that in a field of his own wheat, which he considered at least as pure as that of any of his neighbours, Professor La Gasca, found twenty-three sorts; and he goes on to state the variations in the kernels which occupy each head, and which implied such variation in growth as to necessitate the selection by single kernels in order to perpetuate a variety. In our own cornfield, with certainly no other field cultivated with a different variety nearer than a mile, on the same ear corn-grains of different colour and structure occasionally appear, and there is always a certain percentage of ears of ten and twelve rows amongst the eight-rowed normal ears of the variety. We have in our collection ears of corn with kernels of white corn, yellow corn, and sweet corn in juxtaposition, the male element so overpowering the ovule as to give to it this diverse development, and, as we must assume, chemically unlike as well.

We may next remark how much more quickly the influence of moisture, of dryness, and of heat, avail to change the aspect of the growth and the produce of vegetable life over animal life. We do know that the character of soil has an influence on the cattle grazed thereon, but this influence is seldom of a character which admits of ready definition; on the contrary, the size and shape of the plant, and even the nature of the product, may be completely changed. Thus the hemp plant in India furnishes a resin known as churras, which is stimulant and intoxicating, but does not produce it when the plant is grown in a temperate clime. The ragweed of our fields will mature its seeds and

show a perfect growth on a gravel-bank, the plant being but 2 or 3 inches tall; and the same plant in fertile soil will attain the height, accompanied by a corresponding degree of development otherwise, of as many feet.

Thus we might go on and illustrate from facts which come under the observation of every one, the extreme variability of the plant nature, a variability which is to our advantage, as rendering the plant available to man according as art is exercised by him in developing these variations according to the laws of their structure, in the line of his desires. Every plant with which we are acquainted possesses this power of variation in a marked degree, and the amount of this variation can be artificially determined for it through the processes of hybridisation and of culture as applied to the plant which furnishes the seed from which the individual is derived; and it is this fact which gives to man much power. Each seed possesses its own attributes and its own powers, and its own individuality, so that the conditions for germination and growth being uniform for all, a dozen kernels of corn planted will develop a different germinative power, a different rate of growth, and a different amount of product for each.

Thus in an experiment of ours, kernels of corn were selected of the same size and from the same ear, and were planted, on land made fertile in excess, at the same time and the same depth, and on one plot no cultivation at all, but the weeds pulled by hand; on another plot, the same conditions, but the land kept clean by the hoe. It was observed that there was a different rate of germination for each kernel in the hill, and between the kernels of the adjoining hills; there was a difference in the rate of daily growth between the plants from kernels in the same hill, and that on some day the rate of growth would be reversed as between these hills—one day one plant growing in excess of the others, and other days being the most backward, &c. When the crop was harvested, we found the following for the maximum and minimum product from hills of three kernels planted:—

	Plot 1, Unhoed.		Plot 2, Hoed.	
	Corn (in ear). Lbs.	Stover. Lbs.	Corn (in ear). Lbs.	Stover. Lbs.
Greatest yield per hill	3	$5\frac{1}{2}$	$3\frac{1}{2}$	$6\frac{2}{4}$
Least yield per hill ...	$\frac{3}{4}$	$6\frac{3}{4}$	$1\frac{1}{4}$	$5\frac{1}{4}$
Average	1·8	$4\frac{1}{2}$	2·3	5
No. of ears, all qualities:—				
Largest number ...	9 ears		9 ears	
Least number ...	2 „		3 „	

In experiments with single hills under different treatment, in another plot, the ears varied from three to ten in number, the weight of corn from 1 lb. to $3\frac{1}{4}$ lbs. in the ear, the weight of stover from $1\frac{1}{2}$ to $6\frac{1}{4}$ lbs., and the total weight of hills as harvested from 3 lbs. to $9\frac{1}{2}$ lbs. harvested.

In those plants which have been subjected to culture for the longest time we find variation, as a rule, more marked than in those in a state of nature. It is a curious and valuable reflection that those plants whose origin in their present form antedates the history of civilisation are at the furthest remove from the wild condition, and have become modified to such an extent as to be unable to hold their present forms without the assistance of man. We also find that wherever the part of the plant modified into use admits of a variety of forms as connected with its uses, there such exist. There is, as a rule, but slight variations between the growths of our most ancient cereals, as attention has been paid more to the grain produced than to the plant which produced it: in the cabbage family, however, where the plant rather than the seed is used, we find variation into cauliflowers, broccoli, borecoles, Brussels sprouts, savoys, cabbage, collards, or coleworts, &c., and these varieties all reproduce themselves by seed.

The art of breeding seeds is therefore to produce and select such variations as are found desirable, and then to establish these variations so that they shall be transmissible either in their present or in an improved condition, by seed. The means of breeding is through the act of selection carried on for successive generations under well-considered conditions of environment, by which the heredity of the seed in the desired direction shall be strengthened. This heredity of the seed brings us more closely to our subject.

There are many degrees of heredity, so far as the breeder is concerned. There are some plants in which the tendency of the seedling to grow into a plant but slightly varying from the parent is very strong, and such are usually wild plants which include in their ancestry countless generations of somewhat similar environment, and a uniform natural selection in action which has selected and continuously propagated the type of plant best fitted to exist amidst the dangers and difficulties of the surroundings. With such a plant the first effort of the breeder is to produce a variation, to overcome the tenacity which leads the seed to propagate in the manner of its ancestry. This tenacity is a heredity neither stronger nor weaker than that which is to be found

in plants of a more sportive nature, but is the outcome of a set of conditions which have been of a similar character for a long period. The same kind of heredity, neither necessarily stronger nor weaker, leads the cultivated plant to vary. Hence we may say that fixity or unfixity of type is no proof of heredity, and that it is but in the conditions which have availed in the past that the heredity which produces likeness is to be sought.

This tendency that exists throughout Nature for one life to produce in its offspring the characteristics of its past, as well as the modifications which have availed in its near ancestry, is the law of heredity. It is a true law, which cannot be said to be manifested by exact likeness of an offspring to its progenitor, because we have instances of alternate generation which shows this not to be so; but it is a genealogical expression which is to be interpreted that the life transmits itself in its modifications; and to know what these are, in order to use this law to our advantage, we must have the history of the preceding lives,—that is, a genealogical record. Now, in the case of a seed, we desire to act upon this knowledge of what the law of heredity as applied to breeding is, and not saying that the like seed produces a like seed, must realise that the total seed of a plant may produce some good, some bad seed,—some good plants, some poor plants,—some plants better, some worse than itself; and that it is heredity which produces these variations, and that we can through the process of selection modify the heredity of the future, so as to influence future seedings. It is this gradual gain, through the influencing the heredity of the seed, that concerns the seed-breeder. This would seem to imply that the tendency of the seed is to reproduce the plant from which it was grown. This is indeed so, because, speaking of the plant as a whole, it may be said to have in its structure a species of *inertia*,—that is, it tends to keep the form and condition it already has, except as diverted therefrom by cause. We cannot think of a change happening to a life without some cause to produce it; and in just so far, and in just that direction that causes have acted, and continue to act, must this *inertia* of the plant life be overcome, and the change which is adequate to the cause take place. So far from reasoning to prove that continuation of a form in a species does exist, we prefer to say that it must be so from the law of Nature, and challenge others to show the contrary, the burden of proof being with them. Hence, from our point of view, the variations we produce in a plant must be transmitted through

the seed, unless they are nullified by some opposing or counterbalancing variation which shall disguise their effect. Let us illustrate this fact:—Prof. Buckman, experimenting with the *Vicia sativa*, or vetch, by a series of five selections, so accumulated the variations that occurred, from a plant but a few inches in height, gained plants more than 3 feet in height, and increased the weight of the seeds from half a grain in the original to 1 grain, and then to 1½ grains in weight. Mr. Hallett selected his original pedigree wheat in 1857, the ear being 4⅜ inches long, and containing 47 grains; in 1861 his finest ears were 8¾ inches long, and contained 123 grains. The second year he obtained ten ears to a stool, and the fifth year fifty-two ears to a stool. This was brought about through the selection of variations, and the continued selection, whereby the effects accumulated in the heredity of the plant. In 1848 Prof. Buckman sowed seeds of the wild parsnep and wild carrot, and, by careful selection, in 1851 the plants of the parsnep presented the stems and foliage of cultivated examples, and approached them in the character of the roots. The change effected in the carrots was not nearly so great as that observed in the parsnep, the Professor observes; but still the progress was quite sufficient to show that it is within anyone's power to renew both of these plants in a cultivated form from wild specimens. It is probable that in the Concord grape, and in our fine varieties of cultivated strawberries, we have the action of selected variation to thank for the result, and none of us can fail to have noticed how soon the varieties of any fruit are offered to the public after a break in the wild species or cultivated species has occurred. Indeed, through this power of heredity, this breaking in upon the *inertia* of the wild plant by mankind—this falling back again upon a trained heredity by art—we have accomplished these wonderful results upon the nature of plants, so that now, once cause a wild plant to sport and the way is immediately opened for the breaking up of the original species into numberless varieties, which shall add to the comfort, to the necessities, or to the gratification of mankind.

If such is our power,—if heredity in life cannot be escaped from,—and if it is the causing of variation, and the fixing of the changes induced which concerns us as agriculturists, what practical lesson can we derive therefrom? We will take up the corn plant, and show what capabilities are offered to energetic and skilful effort to improve this plant through the heredity of the seed, because few species are subject to greater or more valuable variations, and

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hence it is especially fitted to respond to any wise effort of ours.

Zea maize, Indian corn, or simply corn, occurs within a wide range of climate, and is modified accordingly in the growth of the plant and the structure of the grain. There is a vast range between the pop-corn, whose normal length of ear is 1½ to 2 inches, and the field corn of from 9 to 12 inches, or even 15 inches; or in the number of rows of corn on the cob, which varies nominally from eight rows to twenty-four or thirty-six rows, as the "Canada 8-rowed" and the "Virginia white gourd" illustrate, and exceptionally even more or less. We find some varieties wherein the arrangement of the kernels on the cob is uniformly 8-rowed; other varieties where the rows may be either eight, or ten, or twelve; others still uniformly 12-rowed, or 16- to 22-rowed, or from 24- to 36-rowed. Some varieties bear the crop near the ground, from the lower nodes of the stalk; others, high up, on the upper nodes; and this feature of the plant is, so far as our observation extends, a true and uniform characteristic of varieties. In shape the ears may be blunt, or pointed after a manner, at the extremities; or may be of a long oval, tapering from a swollen centre towards the butt and tip ends; or may form a true taper from butt to tip; or may be cylindrical throughout. The kernel, again, may be arranged in lines wherein there is a distinct evidence of arrangement in pairs, or without any distinction or manifest separation into pairs of rows. The shape of the kernel may be nearly globular, or oval, or elongated; it may possess a flat point, or a dented extremity, or be furnished with a sharp tooth, either straight or recurved: it may be shaped like a horse's tooth, or be flattened; be longer than broad, or broader than long; may be smooth, or wrinkled, &c. In colour the kernel may be white, pale yellow, translucent, dark yellow, orange-yellow, reddish yellow, red, violet, purple, blue, slate, black, or variegated; in texture may be hard and brittle, softer and granular, and in some varieties almost gummy. Its specific gravity varies greatly—some 8-rowed, yellow, like the "Waushakum," weighing 64 lbs. to the struck bushel; others, like the Tuscarora, weighing seldom 56 lbs. to the bushel. The kernels differ in the structure of their contents: in the pop-corns the oils being distributed nearly universally throughout the kernels; in the varieties of the Canada corn the oily appearance being external to the chit and starchy portions, and forming the periphery from the hilum as a centre; in the dents, the apex being free from

this oily showing; in the true Tuscarora, no oil to be recognised, &c. This arrangement, which furnishes the basis for a practical classification of varieties, seems thus far to have been unused. In the cob we find also differences between varieties which are general for each variety—the large cob and small cob, the tapering cob, the cylindrical cob, the bulging cob, the white cob, the red cob, &c. In habit of ripening, one variety may mature in from 90 to 100 days, while another variety may require from 180 to 200 days. These variations we have mentioned are not in the nature of monstrosities, or exceptional in their nature, but are general, and peculiar to varieties. They are hence strongly inherited, and transmissible by the seed in all cases when other conditions than those which have availed in the past are not brought into interference.

Hence, if sweet-corn seed be planted, sweet-corn is harvested; if a pop-corn, then the pop-corn harvest is obtained; if a red corn, then red ears are gathered; if an 8-rowed corn, an 8-rowed crop, &c., throughout the whole list. As an undoubted fact—a fact which is the explanation of our general practice of planting the seed of the crop which we would gather—each seed has a heredity which causes it to develop the plant in the line of the past growth; and whenever, through natural or artificial agency, the character of the heredity has been determined for the seed, through any process by which like forces are accumulated and stored, we find the corresponding development in the offspring. That law of inheritance whereby we say "like produces like," meaning thereby the great law of continuance of development in the line in which forces compel, is hence so evident that as breeders of seed, or of animals, we can assume it as an axiom, and drop it from our discussion as too well known, too fully realised by the educated and trained mind, to require explanation or illustration. What is of practical concern is the defining of certain kinds of heredity, the accumulation in line of desired tendencies, knowing that the law of likeness is uniform and universal, and acting always within the lines of its application. To mark out these lines, to compel the action in the direction for our profit, is the true art for practical study, use, and endeavour.

If this position be the correct one, as we firmly believe, we may pass to the consideration of "variations," knowing full well that variations in all cases have a tendency, more or less strong, to be continued in the offspring, and that, if we can retain desirable variations for a sufficient number

of generations, that these will become established as permanent.

The production of variations in a plant is easily acccomplished. Any interference with the normal condition will cause them—a change of climate; a little more or less heat or moisture; the influence of crossing with the pollen of another variety; or an interference with the growth of the plant; or abundant or scant nutrition: all these, of the more evident causes, are effectual. A small eared, 8-rowed Canada corn, removed to a more genial clime than where it has been grown, increases in height of plant and in length of ear; a little greater change, and the tendency to increase of rows of grain on the cob becomes manifest. An 8-rowed flint-corn, removed and cultivated in Ohio, in one instance, became, from seven years' use, closely allied to gourd seed, being much dented, and the number of rows on the cob had increased to twelve and twenty. In Louisiana, the continued cultivation of soft gourd seed-corn from the West produced a hard flint-corn with a larger cob, in twelve years. This change, which is too well recognised to require further illustration, is also accompanied by a change in the habit of growth of the plant, which is not confined to the shape, and structure, and composition of the seed, but also to the habits of maturity,—the seed from northern localities, the first year after removal, ripening earlier than the varieties native to the region, but shortly approximating the periods common to the locality. It is this fact which enables the extension of culture into localities whose temperature will not admit of the immediate transference from southern sources, but which can be entered through the gradual cultivation through intermediate stations. Thus the potatoes, which require five months for their development in Germany, are cultivated, according to Leopold von Buch, in Lyngen, two degrees beyond the polar circle, and attaining their full development in little less than three months. The feature to be noted in these cases is, that these variations, brought about through means at the control of man, become fixed in the variety.

The effects of temperature and moisture are of great avail towards changing the habits of the plant, yet from the nature of the case cannot be well separated and defined. We have observed a difference in the transpiration of water from different plants, a variation which is of extreme importance as leading to the selection of that variety which requires the least water for the processes of growth, for planting in drouthy localities, and *vice versâ*. Heat alone,

moisture in sufficient quantity being present, tends to an elongation of the internode of the plant, while a diminution of temperature tends to shorten the nodes, and is suggestive of other changes in the character of the plant and its fruitage. As a general rule, for varieties of corn which are quite similar, elongation of the internodes means an influence on the ear; but there seems to be many exceptions, and the matter is worthy of further study.

The influence of hybridisation in corn is very peculiar, but always results in a change of character in the kernel. Thus we have before us an ear of a pale yellow field-variety which contains sweet-corn kernels, wrinkled, sweet, and of their proper shape. In this case the pollen has determined the development of the ovule of another variety so as to disguise completely the natural order of its development. We have another ear of a deep red corn, whereon the influence of the foreign pollen has been to modify the shape and the colour of the few kernels affected in such a manner that they seem intermediate in character between the two parentages, and in other kernels the influence of the pollination seems to be confined to distinct localities of the kernel. In these variations, these departures from the variety, we have the means at hand for further progress in an intermediate or diverse direction from either parent, because, as is too well known for argument, or even statement, the produce from these kernels would show effects resulting from this departure from the type of either parentage.

The influence of interference with the growth of the plant, in order to produce variation, seems not to have attracted the attention of authors, although of great interest. In some experiments of our own we have found that the obstruction to the flow of sap in the stalk, whether by ligature or by splitting the stalk and injuring the pith in the cross-section, has been in all cases followed by the elongation of the foot-stalk of the ear, and we have thus secured a branching corn-plant. This treatment increased the rate of growth of the plant in height, caused an earlier bloom, and increased the amount of produce over that of adjoining hills not thus treated. The removal of the upper nodes of the plant early in the season has caused a development of ears from the lower nodes, which in the variety experimented upon are universally barren as cultivated in the fields. When the leaves were cut from the ear-wrappings (not the leaf-stalks which form the husk, but the leaf extremities which are formed beyond the ear), the effect on the ear was manifested by irregularity of kernel develop-

ment; when the leaves were reduced on the plant during growth to a large extent, the growth was little vigorous, the plant was stunted, and, although there was an appearance of earing, there were no ears developed into crop, but all were of the class called pig-ears. When the stalks of the plant were daily twisted until a snap could be heard, the earing was very abundant, far more so than in other plants, but all did not develop into crop. When the lower roots were all removed from a plant, by digging up the seed soon after vegetation had commenced, and cutting off all the roots below the seed (removing the radicle), the plant showed a character of growth different from that of normal plants, throughout the season, and tillered largely; one hill which had the flowering-stalks of the plants broken down at the period of bloom gave a better lot of ears, and a plumper kernel, than did another hill whose plants had the flowering-stalk entirely removed; but the number of plants thus experimented on were too few to offer results to afford data for a reliable conclusion.

We now have indicated, in a general way, how variations may be produced, giving data but from experience. We might add, from theoretical grounds, the planting of seed from peloric ears or tassels, from using mutilated seeds, or seed from mutilated plants, from butt kernels or tip kernels, from ears in abnormal positions on the stalk, or from kernels in irregular positions on the cob.

Had we no other means of arriving at a conclusion of the antiquity of maize as a cultivated plant, this very fact of its pliability towards changed conditions, and the manner of its present sportiveness, would be ample. It is indeed far removed from a wild state, and has become domesticated, if we may use the term in this connection. Its present form, in any given case or variety, has been derived from the accumulation of tendencies which have been impressed on its varied generations by the needs of corn-eating man. In those features which have attracted the attention of its growers it shows this variability. In those other features which have been overlooked, and which, if influenced at all by man, have been through correlations, the plant shows a degree of stability which it is difficult to overcome. For instance, the "Waushakum" corn-plant bears its ears on the fifth node from the first, and developes embryo ears at the five nodes counting from the first which sends forth roots. Through no effort of ours have we been able as yet to change its nature in this respect. We have succeeded in causing the ear to be developed on the fourth, or third, or

second, or first, counting downward, but never on the sixth, the seventh, or the eighth. We have not been able, so far as we have observed, to change the plant from a nine-noded one or less, through manure or any other process we have as yet tried. This method of structure has remained constant, because there has been no effort in the past by any one to produce variation, as no variation in this line has promised advantage or been brought to the attention. Yet we have been enabled to vary the grain, the shape of the cob, and the habit of growth, the most readily in those directions in which a practical usefulness could be seen. Indeed the teleological argument is a fitting one as between the plant and man. In other varieties of corn we find a different arrangement of parts, and as strictly defined in the variety as in the case given. Thus a variety grown in Tennessee contains sixteen nodes in all, and the first ear appears on the fifth from the bottom, and on each intervening node up to and including the twelfth. Darling's early sweet corn produces its ears near the ground, as a variety characteristic, as does also the Narragansett, and some pop-corns we have grown. In the Southern white corn, as grown for fodder in New England, the ears develop high up on the stalk.

If we pass to intermediate characteristics, those which probably have been valued as a peculiarity of variety through many generations of culture, we find a fixity which is quite difficult to overcome except through successive efforts, if at all. Colour is perhaps the most prominent. Thus the red corn, occasionally cultivated here and there in New England, and which, although out of general culture, is tenaciously held on to by individuals, presents a fixity of type which overcomes in most instances the effect of hybridisation even in its colour. We know of instances where it is claimed for it that it does not receive hybridisation from other varieties of corn, because the colour continues, but a careful examination of those ears we have seen, and which have been grown among other corn, has shown an influence in the shape and quality of the kernel; and if in a few cases the colour has changed, or become modified, this fact but proves by its exceptional occurrence the fixity of the colour peculiarity. The red cob is another instance in point. We know that some growers place a value on this peculiarity, just as certain features of little real consequence have become valued in poultry by fanciers. We have known of instances where through hybridisation the colour of a kernel and the shape have become changed, while the cob

has retained, apparently, its variety characteristic of a red colour. In the arrangement of the kernels we have a feature wherein there has been little effort to fix the number, as the benefit of a fixity of type here has not been generally recognised. Hence we find in this respect a great variability, and there are but few varieties wherein a good percentage of other numbered rows than the normal number do not appear. Scarcely a field of eight-rowed corn but what will show ten- or twelve-rowed ears to the searcher after them. Scarcely a twelve-rowed corn wherein eight-, or fourteen-, or sixteen-rowed specimens do not exist.

The means in the power of the seed-grower to improve his seed is now indicated, and their efficacy has been shown. It is not heredity; it is not that the seed will produce a plant and a seed like its parent plant; it is no new and novel proposition which has been untried, but, as shown by all the facts of experience and reasoning, it is in the accumulation of desired qualities so as to determine the character inherited; for, let us repeat, even if charged with tautology, that heredity is general in the poor and the good seed alike, in the desirable as well as the undesirable qualities, and that it is but the character of the qualities which are transmitted which concern us most intimately in our efforts to improve. To accumulate good qualities to be transmitted in the stead of less desirable qualities,—to gain even an advance this year, and again another the next, and so on continuously, is the secret of breeding. It is not the plant like the parent plant that is the most profitable, but the better plant than the parent, and all that is to be done is to cause the individual plant to vary for the better, and then to hold on to the gain by each year, each generation to fix this good quality and to add on to it, so that it shall become a characteristic of the variety or the breed. The art of selection, the practice of selection, the continuous adding and subtracting of qualities from our plant is the secret, as well as the plain common-sense of breeding. So long as law prevails and forces act, we have in our plant, in our seed as representative of the plant, the reproduction of those qualities which have been impressed upon it from the past, and by changing these qualities in the present we can pass them along through the intervention of the seed, to future generations, and thus, through the continuous additions and strengthenings, can form the plant which shall devote itself to the carrying out of our desires, and which shall in a measure eventually overcome even what at first thought we would call the design of Nature.

Thus, through selection, winter and spring wheat, which botanically have been considered distinct species, have been transformed the one into the other. The beet-sugar plant, since its introduction into cultivation for sugar in France, has had its percentage of sugar almost exactly doubled through the agency of most careful selection and testing of roots gathered to be used for the growing of seed. By selection during a course of years the early maturity of peas in Great Britain has been hastened from ten to twenty-one days. Among florists' plants the Canterbury bell was doubled by four generations of selection. The wild cabbage plant has been developed into at least ten distinct varieties through cultivation; the crab has been transformed into the apple; the sloe into the plum; the wild grape into the concord grape; the wild strawberry into the large and fine cultivated species, and each year brings numerous varieties thus gained before the purchasing public. The whole secret of all these triumphs being the production of or the seeking for variation, and then putting into action a rigorous selection.

How rapidly changes may take place in a plant through yearly variation is shown by the results of Metzger's growing of corn in Germany from foreign seed. In the third generation, in one case, nearly all resemblance to the original and very distinct parent form was lost, and in the sixth generation this maize perfectly resembled a European variety. In another case, with a "white-tooth corn," the tooth nearly disappeared in the second generation. In our own experience we find that various features of the corn plant resist acts of selection more strongly than do others. It has seemed to us that three generations of selection have sufficed to change the size of the cob and the shape of the cob; that it has had a strong influence in changing the character of the grain, but has not yet fixed it; and that it has had a less effect on the earing habit of the plant, and yet an effect which is very noticeable and persistent.

Let us now consider the corn plant alone, and see what features we desire to obtain, and what must be the principle of selection which would seem the most efficient to bring us success.

As a rule, the one feature of the plant that concerns the farmer the most is that of prolificacy. There is less difference betweeen the values of different qualities of corn grain, from a sale point of view, than there is between the yield of different varieties. Seventy-five bushels per acre of any variety grown is usually more valuable than forty bushels of another variety, and yet these figures represent actual dif-

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ferences which may prevail in the same neighbourhood. Hence how to increase the corn crop is an important question. This cannot be done by manuring alone, or by culture alone, but through the intervention of seed selection. If we plant a kernel of corn by itself, and dung it and care for it, we are sure to have an ear produced from it; and yet if this same kernel be planted in a field where it has to overcome disadvantages arising from the presence of other plants, and less of individual condition concentrated in itself, we are not as sure. In field culture we always find barren stalks in greater or less number, according to variety; we always find small ears—pig corn as we call them—no matter the amount of fertility; we always find perfectly formed and shapely ears scarce. This fact of non-productive plants can be proven by a calculation of the amount of grain which would be harvested from fields variously planted, *provided* each stalk furnished one first-class ear.

To plant an acre in hills $3\frac{1}{2} \times 3\frac{1}{2}$ feet distance, and four kernels in a hill, requires 14,224 kernels of corn. If each produced one stalk only, and one good ear shelling 7 ounces of corn,—not an impossible amount for a first-class ear,—the yield would be 111 bushels. If the acre be planted in drills, $3\frac{1}{2}$ feet apart, and hills every 28 inches, containing four kernels, the number of hills planted is 5335, the number of kernels 21,340, and the yield in the same supposition of 7 ounces would be 165 bushels. As a matter of fact it is not uncommon to harvest 3 lbs. of ears from a hill of three kernels, and 4 lbs. from a selected hill of four kernels, or 1 lb. of corn in the ear to a kernel planted. If we accept this as a maximum our yield would, on the suppositions above, be 355 bushels of ears (40 lbs.) and 533 bushels of ears per acre.

These calculations are not offered to show the crop that may be grown, but simply to illustrate the difference we find in practice between our ordinary yields and yields from the best hills of our field, in order to make evident the proposition that improvement in our seed-corn is needed, and that each farmer can find in his field the hint for the direction of this improvement. Whatever man can improve his seed so that every plant shall be the equal to the best of his planting has accomplished the difficult and scientific feat of the formation of a variety which is at present beyond aught that we have reached.

Now manure will not cause prolificacy to an equal extent in corn plants from various seed, as we have shown that under excessive manuring the variation in crop between

sixteen hills under like treatment has been as 1 to $3\frac{1}{4}$ by weight of corn on ear, and as $1\frac{1}{2}$ to $6\frac{3}{4}$ lbs. of stover per hill. Under ordinary manuring the difference has been nearly or quite as great. Under insufficient manuring the variations appear even greater. We desire to lay stress upon this fact, that manuring does not produce crop by itself, and that increase of manure is not necessarily followed by increase of crop. We know of a field which received thirty-five cords of manure per acre, and yet another field fertilised with six or seven bags of Stockbridge corn manure to the acre gave a larger and fairer yield of corn. On Waushakum farm, one rather poor (as we have considered it) piece of land, which has been heavily cropped by the aid of Stockbridge manures in past years, yielded 66 bushels of corn this year when manured with seven bags of Stockbridge fertiliser; while another field, considered our best land, manured with about $5\frac{1}{2}$ cords of clear cow-dung and six bags of Stockbridge fertiliser, yielded 66 bushels (or exactly $131\frac{1}{3}$, and 132 baskets of 41 lbs., respectively, per acre). Hence manure is but an element, an important one, but not sufficient in itself to furnish us large increase of crop.

Will cultivation do it? We can say also the like for our culture, that it is an important factor in the improvement of corn, and yet is not all-sufficient, being but a factor. In an experiment to determine this we took a suitable plot of ground, and manured it most excessively, so as to eliminate by the abundance of fertility the specific effect of the manure in producing differences between the yields (some forty-two cords of cow-dung per acre, besides abundant chemical fertilisation), and planting in hills 4×4 feet apart, three kernels to each hill, using selected corn and equivalent conditions of planting: we had three plots, each containing sixteen hills. Plot I. received no culture whatsoever, the weeds being pulled by hand. Plot II. was hoed thoroughly and frequently during the season. Plot III. was weeded by hand, as Plot I., but a knife was run vertically around each hill to the depth of 6 or 7 inches, at various times during growth. The following are the results of harvest;—

TABLE I.

	No. of hills.	Weight of corn in ear.	Weight of fodder.	Proportion of ear-corn to fodder.	No. of ears.	Length of ears.
Plot I.	16	$29\frac{1}{4}$	72	1 ; 2·46 lbs.	86	$643\frac{3}{4}$ ins.
„ II.	16	$37\frac{1}{4}$	81	1 : 2·17 „	92	752 „
„ III.	16	$33\frac{3}{4}$	$48\frac{3}{4}$	1 : 1·44 „	104	774 „

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TABLE II.

	Total No. of ears.	No. of good ears.	No. of fair ears.	No. of poor ears.	Ears good as seed.	Merchantable ears.
Plot I.	86	38	6	42	2	44
„ II.	92	57	13	22	5	70
„ III.	104*	47	22	35	26	69

We can study this table with advantage, as there is shown an influence of cultivation upon the ear and upon the crop, which conforms to the general experience of farmers, and hence is undoubtedly a true and not an exceptional influence.

It is to the selection of the seed that we must look for the important factor, which manure and cultivation shall act upon to give the largest possible result. As a rule, seed has been selected with reference to the grain, and not with reference to the plant. We hence find many varieties of corn with grain of superior quality and ears of fair appearance, but the appearance of the ear gives us but little clue to the prolificacy of the plant. In our own experience we have had the results from seed corn from similar ears vary as 2 to 1, or as an actual result 55 bushels of grain per acre from the one, and 110 bushels from the other, under equivalent conditions of treatment. It is to the corn plant that we must look first in the improving of seed corn through selection, and we must bear in mind continuously the principles of breeding, remembering that by a law of nature the seed *must* transmit the tendencies it has itself inherited and acquired.

If there is one principle of breeding which is more fully and satisfactorily determined than another, it is that of the survival of the fittest. That animal or plant which is best fitted to overcome obstacles is the one which in the long run will succeed in establishing itself and its race. If we desire to modify individuals of either class, animals or plants, we by our interference furnish them advantages which aid them in overcoming, or prevent them from coming into conflict with the competition which they cannot endure. Thus our corn plant is protected during growth from competing for the possession of the ground with weeds; it is aided and encouraged through the furnishing of conditions suited to root-extension by means of the plough, the harrow, and the cultivator, &c. If we study the corn plant with reference to

* Three ears of large size too much affected by smut to count in the harvest. On Plot I. considerable smut, but none to destroy the ears. On Plot II. less smut, but no ears destroyed.

its parts, we find the same rule to apply. If we encourage an excess or produce a deficiency of leaf surface, the grain suffers from our interference. If we examine into the physiological structure of the stalk, we find that nature has provided the embryos of many ears, but that in the ordinary course of events, one ear, usually the upper one, develops, attracts to itself through its superior vitality the nutriment from the stalk, while the lower embryos are apparently unable to struggle against this prepotency of the one, and starve. We can state as facts that in a field where the average productive stalk yields but one ear, and this the upper one, its removal will cause the next lower to develop and form the crop; and thus by our interference we can cause the one to develop which we shall aid by removing its competitors in the struggle to secure the advantage.

What conclusion, then, can be logically derived from what we have stated?

1st. It seems to us clear that our first effort for the improvement of seed corn is to remove the changes which come through the hybridising of the corn by pollen from infertile stalks, as thus confining the heredity each year within the lines of productive parents, and thus bringing the heredity to act stronger and stronger in the way most agreeable to our profits. This is one species of selection, one influencing of variation, the selecting of prolific parents, and the causing thereby of variation in the direction desired. This has now been practised for two years with the "Waushakum thoroughbred corn," and the effects are strongly evidenced already, while the show for a still greater improvement is very promising. The inheritance or transmissal of qualities is always present in a seed, but we are securing the transmissal of good qualities, and eliminating the bad qualities—meaning good and bad in their relations to man—by this most influential and important method of selection.

2nd. The next direction for selection, as taught by these principles we have referred to, is of the ear. It is of advantage to select seed from plants which develop twin ears, but as the influence of cross-fertilisation as usually allowed by the grower, is to introduce a tendency to barrenness, this way of improving our yields of corn is slow in practice, and possesses an element of uncertainty which should be eliminated. In using seed of a strong tendency towards developing two ears to a stalk, we obtain perhaps the two ears, but the kernels on these two ears, perhaps, are fertilised by

pollen from a plant which does not develop any ear at all; the seed thus grown has a divided quality; it inherits from the mother plant a tendency towards fruitfulness, and from the father plant the tendency to barrenness, and according to the prepotency of either must the result be. While there is therefore a usefulness in the taking of seed corn from a twin-eared plant, this method of selection must be secondary to the first, so long as barren stalks abound in our fields and furnish pollen.

3rd. There is another method of selection which has a relationship to the 2nd, and which has not in practice, so far as we have observed, received the attention which its theoretical importance would seem to warrant. This is the influence of the position of the ear. The upper ear of the stalk, in many of our New England field varieties certainly, and doubtless in the majority, has a prepotency which enables it to develop normally at the expense of the lower embryo ears. Under moderate or poor manuring, this ear (if any) always, so far as we have critically observed, develops, and none others; under better manuring, a second ear, and always, so far as our observation extends, the one immediately below the upper one may develop, but it is probable will not be the equal to the first: under heavy manuring, a third, or even a fourth, may develop, but the quality is apt to deteriorate as we proceed from the top. This series of facts, if facts they are, indicate that the prepotency of the ears decreases as they occupy positions nearer to the ground. In the selection of seed-corn, therefore, we should endeavour to secure the lowest ear on the stock for seed purposes, as we thus are using seed which by overcoming the difficulties of position has proved itself to have great prepotency and vigour, and as the prepotency increases as we go upward, the selection of the lowest ear gives us the advantage of, as well as selecting, a prepotency of position which shall affect the development of all the ears which grow above it, or a plant prepotency, with reference to its seed bearing qualities, as well as the one prepotency we have selected for continuance.

We thus have indicated the three guiding selections which should be the careful concern of the seed-breeder. How long it shall take to secure the fixity of these qualities by continuous selection we cannot say with certainty for any given case, but for limits we have slight reasons for supposing seven and sixteen years. We know from experience that three years only are productive of recognised benefits.

The character of the grain and its arrangements on the cob, the length of cob, &c., are minor objects for the breeder's care, as requiring less time to fix, as being most readily apprehended, and as showing results so quickly as to encourage continued efforts. These minor characters can usually be fixed by three years of selection, if any variety of ordinary culture be worked on, and if the changes desired are not outside of the fixed characters of the variety. If we shall attempt to change a field corn into a sweet corn through other selections than those influenced by hybridisation between the two, or *vice versâ*, we shall have difficulty, perhaps shall fail, most probably shall not succeed. We can always place our efforts most successfully where the plant experimented on indicates by the nature of its variation the direction for us to act. Do we wish to change an 8-rowed corn into a 12-rowed corn? We shall do it more readily with a variety that presents frequent variations from the 8-rowed form, than with another where this variation seldom occurs. Do we wish to diminish the proportion of the cob to the grain? We can do this more readily with a variety where the proportion already existing is far from uniform, than with another variety where the proportion is quite uniform. Do we wish to lenghthen our ears? We can do this the more readily with a variety which varies greatly in the number of ovaries in line on the cob, than with another which presents a more uniform number, &c.

We believe that by the proper selection of varieties to be used as a beginning to work from, that we can so far offset the influences of climate as to grow a flint corn into a dent corn, or *vice versa*; a pop-corn into a field corn; a yellow corn into a white corn; a flat corn kernel into a rounded kernel; a deep-kerneled corn into a shallow-kerneled corn; an 8-rowed corn into a 10, 12, 16, or more, rowed corn; a large cob into a small cob; a short cob into a long cob; an ordinary variety of corn into a branching variety, &c. We believe that the corn ear can be removed, through selection, from the upper node to an intermediate one; can be borne on branches either terminal or axillary; can be transferred to the tassel, &c. In a word, that under the axiomatic law of inheritance, or the transmissal of forces, the process of selection will produce these changes we have indicated.

What kind of corn should the New England farmer seek to develop? First and last, one possessing prolificacy, as being the most important quality and the most difficult to be attained. Then smallness of cob, as being a correlative with the stalk (to be used and found exceedingly valuable as a

forage plant if small and thus easily cured) and as having a direct bearing on the storage of the crop. A small-cobbed corn can be binned in larger piles and earlier in the season than a coarse-cobbed corn, with less danger from mould, and is earlier to be husked and earlier to be binned, and earlier to be shelled and marketed, on account of the small cob drying out its moisture more readily and quickly. Then length of ear, as diminishing the labour of husking. Then depth of kernel and closeness of packing on the cob, a most evident economy. Then uniformity of kernel, as adapting the grain to more varied uses. Then colour, as having a relation to ease in marketing, because if one coloured corn sells more readily than another coloured corn, it is more desirable to be grown.

We would also call attention to the importance of securing adaptability to climate, and to the farm. This can be obtained by closely watching the corn of the farm, and using the evident changes produced by the locality to influence our selection. If there is a difficulty in keeping a 12-rowed variety from changing to an 8-rowed variety; that is to say, that if the 8-rowed ears are constantly appearing in the crop planted from a 12-rowed seed, then it is probable that your selection had better be towards the 8-rowed variation, rather than attempting to retain the 12-rowed.

The improvement of seed corn through systematic effort, guided by careful study of what facts we possess, has scarcely yet attracted the attention it deserves. Success, it seems to us, can be hoped for, and he who undertakes it understandingly must win some degree of success, sufficient at least to amply repay for the trouble and care, besides the satisfaction which shall attend the effort. It is for farmers to assist such an effort by demanding good seed, and by paying for good seed a price sufficient to remunerate the grower.—*From the Report of the Secretary of Conn. Board of Agriculture*, 1878.

NOTICES OF BOOKS.

Scientific Lectures. By Sir JOHN LUBBOCK, Bart. London: Macmillan and Co.

IN this volume the author gives a clear, though necessarily much condensed, view of the results of modern research on the mutual adaptation of plants and insects, and on the habits of ants—a subject which he has personally investigated with perseverance and success.

A particular interest attaches to the attempt made to explain not merely the general colouration, but even the pattern of caterpillars, by a reference to their necessity for concealment. The view taken by Dr. Weissman in his able monograph on the larvæ of the Sphingidæ, and, we believe independently, by the author, is that longitudinal lines prevail among such species as feed on grasses or other narrow-leaved plants, whilst such as browse upon broad-leaved plants exhibit diagonal bands. Thus *Smerinthus quercus, S. tiliæ, S. populi, and Sphinx convolvuli*—feeding respectively on the oak, the lime, the poplar, and the convolvulus—are all characterised by diagonal lines on their sides. On the other hand, *Anceryx pinastri*, which eats the narrow needle-like leaves of fir trees, has merely longitudinal lines. The chief difficulty in the way is that the larvæ of not a few species have more than one food-plant, and may be found both on broad leaved and narrow-leaved vegetables. Thus *Chærocampa celerio, C. elpenor*, and *C. porcellus* feed upon comparatively narrow-leaved plants, such as different species of *Galium* and *Epilobium*. Certain entomologists, however,—such as Meigen,—declare that they feed also upon the vine, one of the broadest-leaved of European trees. We have ourselves taken *C. celerio* upon the vine, and can testify that *C. elpenor* and *C. porcellus* in captivity feed quite contentedly upon its leaves. Still it is probable that the bulk of these insects found in Europe have been fed upon *Galium*, and are descended from ancestors whose diet has been similar. Hence we need not pronounce it an exception to Dr. Weismann's law if *C. elpenor* and *C. porcellus* have only doubtful diagonal bands, and *C. celerio* none at all. The strongly-marked diagonal pattern of *Sphinx ligustri* may seem unsuited to a species living on so narrow-leaved a shrub as the privet, but the larva feeds also upon the lilac and the ash. The large blue eye-spots of *C. nerii* are explained as resembling the flowers of the periwinkle, on which it is said to feed in this country. On the coasts and in the islands of the Mediterranean, which may be considered its true home,

it feeds generally—some authorities say exclusively—upon the oleander (*Nerium*), from which it takes its name, and whose flowers are well known to be red.

The conclusion most readers will draw from this section is that the colouration of caterpillars is either protective—calculated to withdraw them from observation—or warning, those which are unsavoury, mal-odorous, or possibly poisonous, being strikingly conspicuous.

The author's account of ants, based on prolonged experiment and observation, is exceedingly valuable. Though he has not succeeded in verifying all the marvels told of "our six-footed rivals," he yet assigns them "a degree of prudence superior to that of some savages." If he cannot urge that "ants must be moral and accountable beings" it is because he has elsewhere attempted to show that, even with reference to man, the case is not by any means clear. His observations as to the effects of different coloured light upon ants seem to show that these insects have the power of distinguishing colour, that they are exceedingly sensitive to violet, and that their sensations of colour must be very different from those produced upon us. In this respect, if we may trust the conclusions drawn in the first of these lectures, they differ remarkably from bees.

The last two lectures deal with archæological subjects. Here, as might be expected, Sir J. Lubbock urges upon his hearers the importance of more efficient steps being taken for the preservation of our national antiquities—a question to which the legislature has unhappily so far turned a deaf ear.

For all those who have not time and opportunity to consult the original memoirs this volume will prove at once pleasant and profitable reading.

The Relations of Mind and Brain. By H. Calderwood, LL.D., Professor of Moral Philosophy, University of Edinburgh. London: Macmillan and Co.

The object of this book is to decide the relative claims of the two well-known rival theories of mental life. Is a physiology of brain and nerve a philosophy of thought, emotion, and will? A school of inquirers—numerous, able, and influential—reply to this question more or less distinctly in the affirmative. Thought is by some said to be a result of the brain, just as is bile of the liver, or urine of the kidneys. Others contend that if brain-power and mind-power are not identical, the one is nevertheless a measure of the other. These views the author examines in the light of recent physiological investigations. From an anatomical comparison of several of the best-known

animal species,—such as the rat, the rabbit, the cat, the dog, the horse, the monkey, the ape, the elephant, and the whale,—he concludes that intelligence and brain-complexity do not keep pace. Whilst we accept this proposition, supported as it is by evidence drawn from the comparison of different individuals and races of our own species, we must demur to the author's standard for estimating the comparative intelligence of animals. He takes as a test "the results of training when an animal is brought under the influence of man." In virtue of this test he considers the dog entitled to a higher mental rank than the monkey and the ape. But in our own species we are apt to consider the readiness with which an individual or a race submits to slavery, a proof of inferiority. The comparison, too, is utterly unfair; the dog's forefathers have for many generations been placed in close contact with man, while the monkey is rarely born in captivity, and is studied under all the unfavourable circumstances of a climate unsuited to his health. Man is apt to extol those animals which make themselves the accessories of his vices, and to undervalue such as cling to independence. The best instance in favour of Mr. Calderwood's position—the ant—he has overlooked.

Elaborate brains, he considers, are indicative of a highly-developed muscular system. The instances given seem to us to involve some misapprehension:—"There is the brain of the horse, whose muscular power has come to afford the standard by which we estimate the comparative power of the steam-engine. There is the brain of the anthropoid ape, whose muscular power is such that when full grown a single stroke of its arm causes certain death to a man. There is the brain of the whale, so wonderfully minute in the windings of the convolutions as to be quite singular in this respect; an animal the mere stroke of whose tail can endanger a large ship."

Passing over certain fishes, such as the rays, and the large serpents, as the python and boa, whose brains are simple in structure, but whose strength is certainly no less striking, bulk for bulk, than that of any of the animals here mentioned, we ask if the highly-developed brain of the gorilla is the cause, or even the mark, of its great muscular power, why should man, with a brain still more elaborate, be so much weaker? The demands of the human brain upon the system have by some been alleged as the best explanation of man's remarkable muscular feebleness. However this may be, the author shows, from the independent researches of Ferrier and Hitzig, that a large portion of the brain—including most of the region assigned by Gall, Spurzheim, and their disciples, to the "moral faculties"—is connected with the sensory and motor activity of the nervous system, and serves consequently to regulate the movements of the body. Other portions—the so-called "silent" regions, comprising the frontal lobe—have not been found to respond to

the stimulus applied, and their functions are consequently still unascertained. We cannot help here remarking how completely the once dominant system of phrenology has fallen into discredit in its old head-quarters.

The power of emotion, and of intelligent interest to affect the bodily condition, is discussed at some length, and is, in our opinion justly, regarded as a proof that the mind is something more and other than a mere corporeal function. We may give two facts in point, not adduced by Mr. Calderwood, and both taken from the history of exploring expeditions in savage countries. So long as the party is still advancing, and the minds of the men are engaged with novelties, seen or hoped for, their health is generally fair. But the moment it becomes necessary to return, and pass through scenes already traversed, a breakdown is not long in making itself manifest. Again, the naturalists or other scientific men attached to such expeditions generally show a higher power of resisting malaria, fatigue, &c., than do their companions.

A most interesting incident is quoted from Kruse. "A deaf and dumb boy was in 1805 found by the police straying about Prague, and was placed in an institution for deaf-mutes, where he received instruction. When sufficiently educated to give accurate answers to questions put to him, he gave a description of his former life. His father, he said, owned a mill; he described the furniture of the house and its surroundings minutely; he gave a full account of his life when at home; told that his mother and sister had died, and that his father had married again, and that his step-mother ill-treated him until he had run away. But he neither knew his own name nor that of the mill; he knew, however, that it lay to the east of Prague. Enquiries were made, and the statements of the boy were found to be correct. The police found his home, gave him his proper name, and secured him the succession to his father's property." We think that this case alone is sufficient to warrant the rejection of Prof. Max Müller's celebrated dictum—"Without speech no reason."

The author's weak point is his evident desire to exaggerate the distinction between man and the lower animals. That among the latter, even in the wild state, there exists a conception of duty which in the rook, the ant, and perhaps in other species, takes the form of positive law, is proved by undeniable facts. In such animals, just as in man, though to a less extent, desire is checked by will and reflection.

Mr. Calderwood holds that prior to maturity of brain development "a child four years of age is found to concern itself with rational laws of life, insisting that deceit is wrong, and injustice and cruelty." Where such correct moral judgments are formed we may be sure that hereditary impressions have come into play.

Whilst, however, holding that the author has fallen into not a few errors of detail, for want of a closer knowledge of animal life, and that he has omitted certain considerations which might have been usefully brought forward, we fully admit that he has made good his main point, and has done useful service in drawing attention to the baseless assumptions of modern "somatism." We feel it a pleasant duty to acknowledge the spirit of candour which pervades the book, and its freedom from the *odium theologicum* and that kindred and equally bitter weed *odium philosophicum*.

The Aborigines of Victoria. With Notes relating to the Habits of the Natives of other parts of Australia and Tasmania. Compiled from various sources for the Government of Victoria, by R. Brough Smyth. In Two Vols. Melbourne: J. Ferres, Government Printer. London: Trübner and Co. G. Robertson.

We have here a most valuable contribution to the fashionable science of ethnology. The author, having been for sixteen years Secretary to the Board for the Protection of the Aborigines, has enjoyed exceptional facilities for obtaining information on the customs and peculiarities of the "black fellows." In addition to the results of his own personal observation, he has placed himself in communication with magistrates, missionaries, surveyors, frontier settlers—with all, in short, who, either from their position or their predilections, were able to throw light upon his subject. The outcome of this prolonged labour is a work which in another half century it would be impossible to produce. Mr. Smyth, indeed, modestly characterises his production rather as a "series of sketches" than as a "scientific work pretending to completeness." Still it will be found that he has proceeded in a systematic manner. He describes the physical and mental character of the natives, their numbers and distribution, the education and training of the young, their marriage laws, the disposal of the dead, their daily life, their food, diseases, dress, weapons, tools, and canoes. He then passes over to an account of their legends and mythology. The second volume is dovoted to the languages of the Australian tribes, and embraces a series of appendices by various contributors and an account of the extinct natives of Tasmania.

The principal shortcomings which we perceive are a proneness to needless repetitions, and a manifest tendency to defend, and even to eulogise, the "black fellows," which the facts and incidents brought forward scarcely warrant. Thus after adducing abundant testimony as to the generality of infanticide among the natives, and stating—on the authority of Mr. W. E. Stanbridge

and Mr. P. Beveridge—that "new-born babes are killed by their parents and *eaten* by them and the (older) children," and that "*meals* are too often made by mothers of their own offspring;" after adding that this custom is not a rite, not a sacrifice, he yet feels free to remark that "every newspaper one reads gives accounts of cases of infanticide, as practised by our own people, *far more horrible* than any known to the Australians."

Elsewhere we read that the Australian native has not, like ourselves, had the advantages of thousands of years of civilisation; "he is as he was created!" Whether this dictum agrees worse with the evolutionist or with the specialist view of man's origin it is difficult to say. If we read the author's description of the horrible initiatory rites undergone by Australian boys before they are admitted to rank as men—rites consisting of five successive mutilations, in the last one of which the back, from the shoulders to the hips, is deeply furrowed with sharp flint-stones; if we further study the account here given of their complicated and oppressive marriage customs, their avoidance of different kinds of food,—not as unwholesome or contaminating, but merely as restricted to some one sex or some particular time of life,—we shall certainly be forced to conclude that the native is assuredly not "as he was created," but has either retrograded or "progressed" in a very undesirable manner. Indeed it is difficult, on Mr. Smyth's own showing, to avoid the conclusion that the life of an ape is more wholesome and less irrational than that of a "black fellow."

The exceedingly involved and complicated nature of Aboriginal customs is, however, a most interesting fact. It reminds us of the parallel circumstance that in a state of barbarism, or at the first dawn of civilisation, mankind have generally spoken highly complicated languages distinguished by manifold inflections, and have gradually, as they advanced to a higher culture, tended to a greater simplicity in speech. Do we here recognise a phenomenon of a periodic natu:e? Or are the savages whom we now meet with not in their upward course from the primitive condition of man, or of the anthropoids, but engaged in a career of degradation, such as we unquestionably meet with in various parts of the animal kingdom? From whichever point we regard it the question is beset with difficulties.

A most useful lesson which may be drawn from the work before us is, that the life of a savage is not, as the ignorant imagine, a career of freedom. What with the council of old men, the dreamers and conjurors, and the inviolable customs and superstitions of his race, the individual black fellow is at every step restricted and interfered with. The most searching civilised tyranny—with the redoubtable Mrs. Grundy as a make-weight—is, in comparison, liberty. There is another conclusion which we cannot refrain from drawing: superstition is often represented as the outcome of religion. Yet of the Aborigines,

who are the most abject slaves of superstition, we read here—"I never could discover anything among them approaching to religion."

As one of the attributes of the Aborigines we learn that bodily deformity, in its various phases, is among them substantially unknown. Since we find, however, that deformed and weakly children are invariably destroyed, the absence of physical imperfection is not wonderful,

The author, if we misunderstand him not, seems to consider the "black fellow" as superior to the Malay, the Polynesian, the Chinese, and to the dark races generally. Thus he writes:—"In talking to a clever Australian native one feels that one is speaking to a person who has all the faculties (though undeveloped) of a European; but the Polynesian, the Malay, and some others, have always seemed to me to belong to races having little or nothing in common with the European." Yet whilst thus admitting racial peculiarities, he quotes, with seeming approval, John Stuart Mill's outburst of abuse against the doctrine of heredity.

A very remarkable physical characteristic is put on record. At the Coranderrk Station children from six to ten years of age have "hair on their backs one inch long and more, and as close as it can sit." The absence or scantiness of hair on the human back has been advanced by high authorities as a difficulty in the way of admitting the descent of man from the anthropoid apes. But if the above account is fully verified the difficulty is greatly reduced.

A new light is also thrown on the origin of the dingo, or wild dog. It has generally been considered to have sprung from stray dogs introduced by the first English settlers, and Mr. Wallace hesitates to recognise it as truly indigenous. The author, however, informs us that bones of this species have been found at the depth of more than 120 feet, beneath beds of clay over which lay volcanic ash. At Lake Timboon its remains have also been found in company with extinct species, such as *Macropus Titan* and *M. Atlas*. The presence of a truly native placental animal in that quarter of the globe is certainly a puzzling anomaly.

It will be seen that the chief merit of this work is as being a rich storehouse of facts and observations. When the author attempts to generalise he is less happy.

We cannot conclude this brief notice without calling attention to the munificence of the Victorian Colonial Government in endowing the learned world with a book so admirably got up and so profusely illustrated.

Journal of the Society of Telegraph Engineers. Vol. viii., No. 27.

THE last number of this Journal contains reports of the meetings of the Society held on the 12th and 26th of March and the 14th of May respectively. The more important articles are those on "The Means of preventing Induction upon Lateral Wires," by Prof. Hughes, which has an important bearing on the practical employment of the telephone; on "South African Telegraphs," by J. Sivewright, M.A., giving an interesting account of the peculiar local difficulties which the telegraphic engineers have to put up with in these wild regions, their great enemies being the bullock waggons, which knock down their posts and their drivers who make "contact" with their immensely long whips. The bulk of the number is, however, occupied by a very valuable and complete paper by the Honorary Secretary, Colonel Frank Bolton, extending over nearly seventy pages. The excitement caused by the recent more or less successful application of the electric light to the purposes of every-day life has raised up a swarm of would-be inventors, who put forth as new inventions of questionable value which had long since been comfortably interred in the vaults of Her Majesty's Patent-Office; these have been resuscitated and re-patented, only to be once more left to their fate. One of the first things a reasonable inventor would do (and there are such) would be to enquire whether his invention was original or not. In this enquiry he would be met by a formidable obstacle in the fact that the last Abridgments of Specifications relating to Electricity do not go beyond 1866, and that even the very Specifications themselves are always months behind-hand. So late, indeed, as May 14th of the present year it was impossible to ascertain clearly the details of any patent on electric lighting later than those of last year. Our inventors consequently would be obliged to search through the whole of the electric patents from 1866 to the present time, a task the formidableness of which can only be known to those who have gone through it. Col. Bolton has therefore endeavoured to supply the unaccountable shortcomings of the Patent-Office officials, as far, at any rate, as the electric light is concerned, by publishing in a classified list a series of copious abstracts of the Specifications of all the Patents in any way relating to the electric light which have been taken out since 1841, as well as short descriptions of all the discoveries connected with it which have been made since Faraday first procured a spark from a revolving magnet, the whole being brought down to the present time. Col. Bolton divides his subject into two parts:—I. Dynamic and Magneto-Electric Machines. II. Lamps, each part being again divided into sections, devoted to a particular type of machine or amp. Most of the sections are preceded by a short account of the peculiar characteristics of each type of machine or lamp.

With regard to the manner in which Col. Bolton (who acknowledges the valuable assistance rendered him by Prof. Ayrton) has performed his irksome and laborious task we can only agree with Major Webber, who proposed the vote of thanks customary on such occasions, "that the Paper may be looked upon as an epoch on the question of electric lighting." Electricians who are ambitious of discovering the light of the future have now a point from which to start, and Col. Bolton's Paper will not only prevent them from re-inventing abandoned inventions, but will stimulate discovery by showing where, and possibly why, their predecessors have failed.

The Paper is illustrated by eighteen figures.

An Introduction to the Practice of Commercial Organic Analysis, &c. By ALFRED H. ALLEN, F.C.S., &c. Vol. i., Cyanogen Compounds, Alcohols, and their Derivatives, &c. London: J. and A. Churchill. 1879.

MR. ALLEN deserves the thanks of chemical students for having brought together within a small compass a large amount of information relating to the proximate analysis and detection of the better-known organic products used in every-day life, such as glycerin, carbolic acid, quinine, &c.

The Introduction gives instructions for the preliminary examination of organic substances in general. The body of the work begins with the particular examination of such substances as the cyanogen compounds; methylic, ethylic, and amylic alcohol, and their derivatives, acid, alkaline, and neutral; glycerin; the chlorals and chloroform; the vegetable acids; and, lastly, the phenols and their acid derivatives.

The general method in which Mr. Allen treats each substance is to first give its formula, and then its method of preparation, its physical and chemical properties, and the characteristic tests for distinguishing its presence and estimating its quantity. We think, however, that Mr. Allen has unnecessarily added to the bulk of his book by giving a number of details respecting the substances of which he treats, which are to be found either in the worker's memory or in any of our common text-books. He seems to have forgotten that his book is a working manual of analysis, and not a descriptive treatise. The four pages on Ultimate Organic Analysis, too, might have been replaced by a few lines giving the bibliography of the subject. There is an excellent table showing the fusing- and boiling-points, specific gravities, &c., of over fifty of the better-known organic substances. A copious index ends the volume.

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CORRESPONDENCE.

EXTRAORDINARY SEASONS.

To the Editor of the Monthly Journal of Science.

Sir,—Perceiving an article on "The Anomalous Season" in your Journal, I forward you the following paragraph from the "Kentish Express." Neither of the seasons therein mentioned agree with an eleven years' cycle. The hot, dry season, 1818, is distant only seven or eight years from the two next similar seasons, viz., 1825-26, and if we add a successive period of eleven years to 1818 we get the series 1829, 1840, 1851, 1862, and 1863, which were certainly not seasons noted for heat and drought. A ten-years' cycle would include 1858 and 1868, which were both fine.—I am, &c.,

A Constant Reader.

"Mr. Shadrach Luckhurst, of the Charity Estate, Willesborough, a retired agriculturist, who for a period embracing a long life-time was engaged in farming the parish of Hinxhill, thus writes of one or two past seasons within his recollection. He says:—'1816 was a year never to be forgotten as the wettest, coldest, darkest, and most unfruitful on record. An immense quantity of corn never came to perfection, but blackened, mildewed, and rotted on the ground. The summer of 1818 was the longest, hottest, and driest I ever remember. A hilly field facing the south was sown with wheat in the autumn of 1817. It was cut fully ripe on June 29th, thrashed on July 3rd, ground on July 4th, and bread was made from the flour on the same day. This was the earliest wheat I ever saw. In this year the harvest was general by July 7th, and it was all cut and cleared by the 25th of the month. The whole country was of a uniform brown colour; not a blade of grass, not a turnip or cabbage was to be seen. Cattle perished for the lack of pasturage and water. For all that the year was the most plentiful, fruitful, and prosperous within my recollection."

PROCEEDINGS OF SOCIETIES.

ROYAL SOCIETY, *June* 19.—"Note on 'Spectroscopic Papers,'" by G. D. Liveing, M.A., Professor of Chemistry, and J. Dewar, M.A., F.R.S., Jacksonian Professor, University of Cambridge. In a recent communication to the Royal Society, Mr. Lockyer has criticised the author's statement of Young's wave-lengths identifications of certain chromospheric lines. As to the wave-lengths, the authors throughout their table omitted all figures after the decimal point merely for the sake of not cumbering the table. The numbers, Young mentions, are not his own, but taken from Angström's catologue. Moreover, as to Young's identifications with metallic lines, he states expressly that they were taken from the maps of Kirchhoff, Angström, and Thalén, and Watts's "Index of Spectra." Their object was not to criticise Young's work, but only to use it for the purpose of comparing the behaviour of certain metals on the earth and in the sun, and the conditions under which certain lines appear, or do not appear, or are reversed. They mentioned, in relation to aluminium, the two lines with wave-lengths 6245·4 and 6237·3 seen by Young, not because they thought their identity with the aluminium lines proved, but because they are the only two lines in Young's table which are at all close to aluminium lines, and if they be not due to that metal, then there is the remarkable fact that aluminium in the sun gives no lines either dark or bright except the two which have been reversed on the earth. A somewhat similar remark applies to the potassium lines, only in that case Young's line has a wave-length very nearly the mean of the two potassium lines which are often seen as one, not merely from want of dispersive power (which with prisms is usually sufficient at the violet end), but because the lines are expanded until they meet. The authors at first saw them reversed as one broad line which divided in two as the potassium evaporated. The authors never set themselves to determine exact wave-lengths; but they sought to determine the conditions of reversal, and they used wave-lengths for the convenience of indicating the lines of which they wrote. In general they determined the identity of a dark line with the corresponding bright line by observing that both had the same place on the cross-wires, or pointer, or both gave the same reading of the scale of the spectroscope. They then gave the wave-length of the bright line as determined by some good authority, usually either Thalén or Boisbaudran. When they could not identify the dark lines in that way, they took the readings of known lines with their spectroscope, using, for lack of sunshine, most

frequently Boisbaudran's method and wave-lengths, and having drawn a curve, determined the wave-lengths of the dark lines therefrom. It was in this way that they obtained the wave-lengths of the two dark lines they ascribed to potassium. It is, of course, just within the bounds of possibility that the line for which they obtained the wave-length 4045 may have been an iron line reversed, but, as the principal well-known lines of potassium were at the same time seen bright in the spectrum while those of iron were not seen, it is far more probable—almost certain—that the line was really due to potassium, and the last figure of the wave-length wrongly determined. To attempt to determine wave-lengths to any greater degree of nicety would, so far as their purpose was concerned, have been labour thrown away. Whenever the wave-length of a line observed by the authors to be reversed is given differently from that given by Thalén and that given by Boisbaudran for the bright line to which they assume it to correspond, it was determined in the way above described. The authors state that by their method of working the very high dispersive power required for the specific identification of any substance by the determination of an individual wave-length is avoided; as they depend on the greatly diminished likelihood of error when several groups of lines of the same substance are seen to be continually present at the time of one or more reversals. It was the necessity of being able to rapidly sweep the entire spectrum for the above purpose that caused them to limit the dispersion. A large majority of the wave-lengths given by Thalén were obtained by means of the moderate dispersion of one bisulphide of carbon prism, a less dispersion than we have used; and they consider it would be incorrect to suppose that no enduring work in this field of spectroscopy can be effected except with the enormous dispersive power which Mr. Lockyer recommends.

"Microscopical Researches in High Power Definition," by G. W. Royston-Pigott, M.A., M.D. Cantab., F.R.S. In its general scope the paper is intended to deal with difficulties in microscopic research, usually found insuperable—such, for instance, as the invisibility of minute *closely packed* refracting spherules, existing in double rouleaux, or promiscuously aggregated; when their individual diameter varies between the 1-80,000th to the 1-200,000th of an inch. These difficulties are principally created by overlapping images—due partly to residuary aberrations both spherical and chromatic—partly to the effects of diffraction, caused by brilliant illuminations of spurious disks of light—partly to the constant development of Eidola or false images, which vary the loci of their development according to the nature of underlying structures; and according to the object-glasses being over or under corrected—and partly, and indeed very considerably, created by the use of excessively large

angular aperture. The paper discusses also the relative effects on visibility, of large and small angular apertures in objectives. It shows that the black margins or black marginal annuli of refracting spherules, constantly displayed by low aperture glasses, are attenuated gradually to invisibility as the glasses employed are endowed with the largest apertures. That the black margins also of cylinders, tubules, or semi-tubules suffer similar obliterations. And that, in consequence, innumerable minute details are concealed or destroyed till the aperture is sufficiently reduced. That minute refracting bodies obey the laws of their refrangibilities and display beautiful phenomena, discoverable by transcendent powers of definition; but totally unseen by inferior compensations. And that, in consequence, the so-called achromatism of modern glasses is an illusory approximation to correct vision. Examples are given of molecular structures, varying in form, translucency, and refrangibility, in which natural pencils are caught and displayed in the order in which, as in a rain drop, iridescent rays are emitted by the decomposed light. Several examples are also introduced, in which a high order of lenticular correction beautifully discovers structure hidden, according to Dr. Carpenter, F.R.S., from the great bulk of observers. As the paper deals so often with magnitudes very much less than the 1-100,000th of an inch, a method is introduced of readily estimating roughly such magnitudes between the 1-80,000th and the 1-500,000th of an inch, by means of a micrometer gauge. The writer has been emboldened to grapple with these difficult minutiæ, in consequence of the sharp and clear definition he has attained of spider lines miniatured down to the fourteenth part of a hundred-thousandth of an inch. The eye, accustomed to contemplate this subtlety of form, readily appreciates the one-fourth or sixth of this size—*i.e.*, 1-400,000th or 1-600,000th. The writer has also brought before the notice of the Royal Society a new test for the microscope, displaying bright lines of uniform thickness less than the 1-100,000th, and sharp black lines of much less tenuity than those given by Nobert's celebrated lines ruled on glass, and incomparably more easy of illustration. The employment of various fluids for immersion lenses is carefully considered; and the singular property of castor oil discovered by the writer is referred to. But, as the author's paper on "A Searcher for Aplanatic Images" was inserted in the "Transactions," he now introduces a new form which offers some advantages: by its extended traverse, by its simplicity and economy of light with increase of magnifying power. Finally, some examples are given of producing transcendentdefinition in cases found hopeless by a numerous body of observers. The means also of its attainment are minutely described.

"Preliminary Note on a new Tide-predictor," by E. Roberts, F.R.A.S. The Indian Survey Department having under-

taken the superintendence of tide-registration around the whole sea-board of India and at the port of Aden, and also the reduction of the observations by the method of harmonic analysis, with the view to the prediction of tides for the whole of the ports, it became a matter of necessity, in order to save the large outlay which the numerical operation of their prediction would have involved, that an instrument should be constructed to delineate the predictions. Accordingly, on the recommendation of the Surveyor-General of India, Mr. Roberts was desired to design, and to undertake the construction of, an instrument to include such a number of tide-components sufficient to predict the Indian Ocean tides with all the accuracy necessary for practical purposes. The present machine is the outcome of the recommendation. The instrument combines the following twenty tide-components:—The mean lunar semidiurnal, the first and second overtides of the mean lunar semidiurnal, two *elliptic* lunar semidiurnal, two *evectional* lunar semidiurnal, one *variational* lunar semidiurnal, the mean solar diurnal, the mean solar semidiurnal, the lunisolar-semidiurnal, the lunisolar diurnal, the lunar diurnal, the solar diurnal, one lunisolar elliptic diurnal, one lunar elliptic diurnal, one compound (Helmholtz) lunisolar semidiurnal, one compound (Helmholtz) lunisolar quarter-diurnal, the solar annual, and the solar semiannual. The chief difficulty in the construction of the machine is the finding, within reasonable limits, of proportions which shall represent with sufficient accuracy the periods of the several components, in order that the machine may be used for a considerable period of prediction—say, for twelve months. Very great success has been attained in this respect in the present instrument. For instance, the error of the period of the chief component (the mean lunar semidiurnal) relatively to the mean solar semidiurnal is inappreciable during a whole year's predictions, amounting to about 0·10° only in a period of fifty years. The largest deviation from strict accuracy is 0·37°, after a run representing twelve months. This is, however, of one of the very small components, and insensible in its results. This part of the design may be therefore regarded as practically perfect. The setting of the machine for the prediction of the tide-curves of any part for which the tide-components are known is as follows:—The dials are first turned so that the epoch or time of maximum is exactly under or above the highest or lowest point according as the component is situated on the upper or lower row of components. The cranks are set vertically (the slotted cone of the wheel on the axis having been first released) and the guide-pin thrown out to its proper range to represent the half-amplitude of the component. The proper positions of the hands having been previously determined by calculation for the time of starting, the hands are set and the slotted cones tightened up. The re-

cording barrel is then set to the time and the wheelwork set in motion. The complete setting occupies only a few minutes.

PHYSICAL SOCIETY, *June* 14, 1879.—Prof. W. G. Adams, President, in the chair.

Prof. Macleod described a plan for Suppressing the Induction Disturbances in a Telephone Circuit. The method suggested is the employment of a shunt consisting of a cell containing platinum plates or wires in very dilute sulphuric acid. The induction currents on the line, having a high potential, escape through the shunt to earth, while some of the telephonic current passes to the telephone. In this way the induction currents are entirely removed, while the sound of the voice is only weakened.

Dr. O. J. Lodge exhibited his New Reversing Key for Electrometer Work, which is preferable to the ordinary forms, as giving a high insulation, small capacity, and not requiring the hand to approach close to it to work it. It consists of four platinum wires, arranged in pairs crossing one another; one pair crossing between the other two. These are the terminals and contact pieces of the key. The middle pair are supported by an endless silk thread, which runs on two pulleys, one of which is fitted with a handle. On turning the handle to right or left the two middle wires are brought into contact with one or other of the two outer wires, and the current reversed at will. The whole is enclosed in a metal box.

Mr. J. F. Moulton then demonstrated the results of the experiments of Mr. Spottiswoode and himself on the Sensitiveness of Electric Discharges in vacuum tubes (see "Monthly Journal of Science," 3rd series, vol. i., p. 443).

June 26.—Earl Rosse in the chair.

An extra meeting of this Society was held on the above date at Cooper's Hill Indian Engineering College on the invitation of Col. Chesney, R.E.

Prof. Unwin, of the College, read a paper on "Experiments Relating to the Friction of Fluids on Solid Surfaces against which they rub." It has long been known that a board dragged through water suffers a resistance varying in some way as the square of the velocity, that a stream has a uniform motion at such a velocity that the component of the weight of the water down its inclined bed is balanced by the fractional drag on the bottom. The fluid in the neighbourhood of the stream is known not to move as a solid mass, the centre moving faster than the sides, and the different fluid layers rub against each other. The adhesion of the fluid to the solid, against which it moves, also gives rise to a sliding or shearing action. Our knowledge of the subject has hitherto been gained from observations on pipes, streams, and from the experiments of the late Mr. Froude with

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a plank of wood drawn through the water of a canal. It is desirable to have a set of laboratory experiments, however, as the conditions can be varied more than can be done by such methods, and for this purpose the author had designed a special apparatus. In Mr. Froude's experiments there was a practically unlimited mass of water and a definitely limited extent of solid surface; and his results are not free from certain anomalies. The author thought it might be instructive to try the other case of a limited mass of water, and a virtually unlimited surface; a disk in rotation gives such a surface. In some respects a cylinder would (as suggested by Prof. Ayrton) be the simplest to treat theoretically, but there are experimental difficulties in its way. The apparatus of the author consists of a metal disk rotated on a vertical axis in a vessel of water; and the problem is to determine its resistance to rotation, since this will be equivalent to the water friction upon it. Within the outer vessel is placed a thin copper chamber, the diameter of which is unalterable, but the depth is variable at pleasure. The disk is placed concentrically inside the chamber, where there are two cheese-shaped masses of water, one above and one below the disk, which are dragged into rotation next the disk and retarded next the sides of the pan. The couple required to rotate the disk is equal to the couple exerted by the disk or the fluid when the motion is uniform. Hence the tendency of the chamber to rotate is measured by suspending the latter from three wires in a manner similar to the bifilar suspension of magnets. An index marks whether it rotates or not on a graduated scale, and a weight suspended by a cord measures the force required to keep the index at zero. Let M be the moment of the fractional resistance of the disk; N the number of revolutions per second. Then $M=CN^x$, where C and x are constants. The author has obtained a number of results, which are, however, not yet ready for publication. He mentioned, however, that a rough cast-iron disk has a frictional resistance almost exactly as the square of the velocity; whereas a turned brass disk gave a value of x decidedly less than 2. The resistance is a little greater when the mass of water is larger. These results were calculated for a speed of 10 feet per second. The author hopes to try the effect of temperature, &c., on fluid friction, and viscous as well as thin fluids.

Prof. Unwin also exhibited a piece of apparatus with which he hopes to study the stress of rivetted plates under shear by means of elastic substances, such as caoutchouc. He purposes to stretch the rivetted caoutchouc and photograph the appearance of stress-lines upon it.

Lieut. G. S. Clarke, R.E., explained the process invented by Prof. McLeod and himself for determining the absolute pitch of tuning-forks (see "Monthly Journal of Science," 3rd series, vol. I., p. 257).

Prof. McLeod then described an electric clock used in the experiments on tuning forks. A zinc and steel compensating pendulum moved by its own gravity; but at each beat made and broke a battery circuit by means of two bent springs, one on either side. The current passing through an electro-magnet detained a bent lever until the pendulum swung to the other contact. By this contrivance time was marked. Prof. McLeod found that the platinum contacts frequently stuck together in these experiments; but this defect had been cured by the use of a liquid shunt of dilute sulphuric acid, which destroyed the extra current. This remedy had been suggested to him by Lord Rayleigh. Prof. McLeod demonstrated the complete success of this device, which acts as well as a condenser shunt. He had also observed a curious effect with these liquid shunts, which as yet he could not explain. Two shunts, having the same acid in both, were employed, one shunting the extra current from four Daniell cells and one that from two Daniell cells. The first showed evolution of H and O gas, the platinum electrodes being unaffected. The second showed no evolution of gas, but one platinum plate was dissolved away and deposited in a black powder on the other. He also exhibited a new cell formed of zinc and mercury plates, with zinc iodide solution and mercurous chloride salt. Red iodide of mercury is formed at the negative electrode. The E.M.F. is seven-tenths of a Daniell-cell, but the interval resistance very low and the cell very constant, while there is no local action.

Prof. Guthrie suggested that as the extra current was really a succession of sparks the platinum might be carried bodily over from one electrode to the other.

Mr. F. H. Varley stated that Mr. F. Higgins had observed a similar effect with carbon electrodes in a voltameter, one carbon falling away into a fine powder, and due perhaps to the disintegrating action of liberated gases. He had also himself seen a platinum wire in contact with a carbon one eaten thin and drawn into very fine silky pens, while the carbon was stained blue, although the current passing was of low tension.

Mr. Chandler Roberts suggested that perhaps a hydride of platinum was formed in the case mentioned by Prof. McLeod.

Prof. Guthrie suggested experiments with fluorescent liquid shunts in the dark.

Mr. J. W. Clark then described some experiments on the surface tension of sulphurous anhydride sealed in a capillary tube within a second tube containing the same substance. He found that at low temperatures the level of the liquid is lower in the narrow than in the wide tube. As the temperature rises the meniscus in the narrow tube descends, till at about 156° F. it is level with that of the wider tube, both surfaces being slightly concave. About this temperature the surfaces become plane then concave, the level in the wide tube becoming higher than

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that in the narrow one. The experiments are being continued, and Mr. Clark's other results will be communicated to the Society later on.

June 28.—Prof. W. G. Adams in the chair.

Prof. W. G. Adams, the President, exhibited his new measuring polariscope. It consists of three principal parts. The lower section consists of a mirror, a lens, a Nicol's prism, and two other lenses. The upper section consists of lenses and Nicol's prism arranged in the reverse order. Each lens and Nicol's prism is supported separately by screws, and its position can be altered independently of the others. These two parts form a complete polariscope. Besides these there is a middle piece, consisting of two lenses (nearly hemispheres), forming a box to enclose the crystal immersed in oil, their curved surfaces being concentric. The whole middle piece is supported on the tubes of the upper and lower portions, and may be turned about the optical axis of the instrument. The vertical graduated circle carrying the central lenses and crystal may be turned through an angle about its horizontal axis. By means of an arc fastened perpendicularly on the graduated circle, with its centre at the centre of curvature of the central lenses, the crystal may be turned about another horizontal axis at right angles to the former, so that the crystal and the central lenses can be turned about each by three axes which are mutually at right angles. By means of a system of toothed wheels in gear with the rims of the central lenses, the crystal and central lenses may be turned separately about the optical axis of the instrument, so as to bring the planes of the optic axes of a biaxial crystal parallel to the plane of the vertical graduated circle.

Sir John Conroy, Bart., read a paper "On the Distribution of Heat in the Spectrum." After referring to Dr. J. W. Draper's supposition that all the rays in the spectrum have the same heating effect, and to his statement that owing to the unequal dispersion of the prism for rays of different refrangibility the method that has been usual for determining the calorific intensity of the various parts of the spectrum is an essentially defective one, the author described a graphical method for eliminating the effect of the unequal dispersion of the prisms, and showed that from MM. Fizeau and Foucault's reassurements, and also from those of Lamansky and Prof. Tyndall, that the maximum intensity is about the middle of the visible spectrum and not at the red end; and, further, that the curves given by various observers as representing the intensity of the heat in different portions of the spectrum are, in reality, the "dispersion curves" for the particular prisms employed.

Captain Abney, R.E., called attention to his published paper "On the Measurement of the so-called Thermo-Spectrum," wherein he shows that the distribution of heat in the spectrum

is a misnomer, and that what was really measured by Lamansky and Tyndall was the energy absorbed by the lampblack and the absorption due to the prisms used. He considered that there was no inherent heat in the spectrum. He found that Dr. Draper had not taken into account the amplitude.

Prof. Guthrie said that Captain Abney had expressed what many thought—namely, that heat was radiant energy.

Mr. Grant then described an investigation which he had made into the induction lines round two parallel coils of wire in the primary coil, an intermittent current of electricity from a Leclanché battery flowed; and in the secondary, a telephone was connected up to detect the induction sounds. With this apparatus he found that with the coils kept parallel to each other there were lines, or rather a surface of minimum induction, surrounding the primary, and that if the secondary were placed in these lines hardly any induction noise could be detected. A diagram, representing a medial section through the coils, showed the lines to proceed from the wire of the coils in two curves resembling parabolas, one from each cross section of the wire outwards.

Dr. Shettle then described his experiments proving the lines of force in a bar magnet to run spirally round the bar between the equator and poles, the equator being decentred and oblique across the bar, as shown by diagrams.

Prof. Rowland, of Baltimore, made some observations on the new theory of terrestrial magnetism of Profs. Ayrton and Perry (see "Monthly Journal of Science," 3rd series, vol. i., p. 287). He said the experiments on which the theory was founded had been attributed to Helmholtz, but they were entirely his own, he having gone to Berlin to make them. The new theory had occurred to himself on making these experiments, but he had rejected it because he found that the potential which the earth's surface would require to have would not only cause violent planetary disturbances, but by mutual repulsion drive objects off the earth. He had made also an experiment to see if absolute motion of electricity would cause magnetisation, but failed to get any effect from it. Then he resorted to calculation to find the magnetic effect of relative motion by rotation of a changed sphere of perfect magnetic permeability that is more magnetic than iron. He found that when the sphere was uniformly charged and rotating there would be a magnetic field in its interior; but, instead of the result of Messrs. Ayrton and Perry, that if the earth were charged to a potential of, he believed 10^8 volts relatively to interplanetary space, the earth's magnetism would be what it is, he found the necessary charge to be $61+10^{15}$ volts. In the ordinary atmosphere this potential would produce a spark nine million miles long, and discharge across to the moon. If the moon were electrified to the same degree, the mutual repulsion would overcome the force of gravity between them. He

therefore considered terrestrial magnetism to be still a mystery. He had also thought that the aurora borealis might be explained by supposing the upper regions of the earth's atmosphere electrified. The winds carrying the upper strata towards the poles, electricity would condense there. This hypothesis is tenable still.

Prof. Ayrton said that whether or not the new theory of magnetism should be so rejected depended on whether or not Prof. Rowland's calculations, or those of himself and Prof. Perry, were wrong. It had been found by Sir William Thomson, from experiments at Arran, that the earth was electrified with respect to the air, and that there is a difference of potential of 30 volts between earth and air for each foot of ascent. This gave 1360×10^{12} centimetre-gramme second electrostatic units as the potential of the earth. The new theory required the potential to be 1011×10^{11}, or supposing the earth to be solid iron, or about 14 times more, a wide margin.

Prof. Rowland said he had not seen the calculations of Profs. Ayrton and Perry yet; but he believed his results to be correct, as he had checked them in various ways.

Mr. Bailley exhibited a modification of Arago's experiment, in which a copper disc is caused to rotate continuously by changing the polarity of four electro-magnets underneath by a revolving commutator.

Mr. Conrad Cooke exhibited a single voltaic element showing the internal current. This is done by forming the glass vessel containing the element into a helical tube between the poles, and hanging a galvanometer needle in the interior of the helix: the internal current deflects the needle.

NOTES.

Biology.

It must be remembered that in addition to the animal and vegetable kingdoms certain biologists admit a third, the protistic kingdom, consisting of the lowest forms of life, holding a doubtful or intermediate position between animals and plants. As such Prof. E. Haeckel ranks the *Thalamophora*, *Radiolariæ*, *Myxomycetes*, &c. To such beings he considers it probable that a polyphyletic origin must be ascribed, the same forms having probably originated at different times and places. Vertebrate animals, including man, are clearly of monophyletic descent. From the *Amphioxus* to man they are the issue of one and the same ancestral group. As regards the Arthropods the case is less certain. Either the Tracheata are descendants of the Crustacea or the Arthropoda are in their origin diphyletic. Among the Echinoderma unity of origin appears certain, and among the Mollusca, again, it is the most probable. As regards the vegetable kingdom, the Phanerogams and the Prothallophytes are probably of monophyletic origin, whilst the Thallophytes are as probably polyphyletic. A similar distinction may be drawn as regards the organs of living beings. The author divides them into typical or semantic,—such as are peculiar to a single class, such as the dorsal cord and vertebral column of the Vertebrata, the tracheal system of the Tracheata, &c. These he considers as having been evolved only in one place and on one occasion. On the other hand, the asemic or atypical organs are found under analogous conditions in various groups, and may have originated independently in a number of cases. Instances are the locomotive, the sensient, and the sexual organs, the heart, &c. A similar distinction may be traced even in languages, the higher being of monophyletic origin and the latter of polyphyletic.

Dr. Bordier has communicated to the Anthropological Society of Paris the results of a comparative examination of the skulls of thirty-five murderers. All of them are of considerable size, resembling in this respect pre-historical crania, and having, like to them, a small frontal development with the parietal region predominating. These large cranial capacities are often associated with cerebral anomalies. The author had recently in his employment a man, decidedly below the average in intelligence, whose skull, after his death, exceeded 1500 c.c. in capacity. The brain presented a conformation peculiar to certain pachyderms. The skulls of murderers present a number of defects and ano-

malies. Dr. Bordier gives the history of some of their owners, in all of whom appears atavism, morbid activity, and a want of equilibrium between the frontal and the parietal faculties. Heredity is manifest in most cases.

M. Décharme describes in the "Comptes Rendus" a remarkable flight of butterflies (*Cynthia cardui*) observed at Angers on the 10th of June. It is calculated that 40,000 to 50,000 of these insects traversed the Rue du Mail, leading to the river, within an hour. They passed swiftly in a general direction from east to west, flying at the height of from 1 to 2 metres above the ground. A violent storm took place to the east and south of the town during the following night. On June 3rd M. Genevay-Montez observed a similar migration of the same species in the valley of the Rhone.

Dr. P. Mayer has laid before the Lyncean Academy his researches on the antennæ of certain Diptera, such as *Syrphus balteatus*, *Eristalis tenax*, *Musca vomitoria*, &c. He finds in the terminal joint certain cavities lined with a sensitive membrane, and serving as organs of smell or hearing.

Most naturalists who have had occasion to walk much about grass and stubble during August have been annoyed by the irritation caused by the harvest bug (*Trombidium autumnale*), an Arachnoid which buries itself in the skin and dies there, causing in most instances troublesome sores and much pain. In most cases the nature of the irritation is misunderstood, and the parts affected wrongly treated. Upon application to a country chemist some ammoniacal preparation is usually supplied, which fails to give relief as it would do to the sting of a gnat or wasp. The wound of the harvest bug should be treated as a sore containing putrid animal matter. The following lotion answers well:—Vinegar, 40 parts; Calvert's carbolic acid, 1 part: mix with an equal proportion of water before use, and apply to the parts affected: it not only heals speedily, but, from its strong and persistent odour, in a great measure prevents further attacks from the very annoying insect.

Chemistry and Technology.

Attention has been drawn to the presence of arsenic in dark water colours by the sudden death of a mechanical draughtsman. In the "Chemiker Zeitung" Dr. H. Fleck states that on a *post mortem* examination the cause of death was first supposed to be an oxalate, and then a narcotic poison. Chemical investigation, however, showed that the liver, kidneys, lungs, heart, and brain were impregnated with arsenic, though the œsophagus contained not a trace, and the stomach with its contents gave a barely perceptible arsenical mirror. The general circumstances of the case excluding the suspicions of suicide and of malicious

poisoning, it was found that the deceased had been in the habit when drawing of passing the pencil filled with colour between his lips in order to point it. The water-colours he had used were analysed, and whilst indian-ink, gamboge, carmine, red eosin ink, neutral tint, &c., were found perfectly free from arsenic, a sample of sepia contained 3·08 per cent of arsenious acid, terra di sienna 3·14, and a reddish brown colour, the name of which was indistinct, 3·15. Burnt sienna, Vandyck brown, bistre, bladder green, brown ochre, indian red, umber (raw and burnt) were also found arseniferous. The exclusion of arsenic from such colours, in which it seems to play no essential part, should be insisted on by the authorities. Most of these colours are essentially iron lakes. Hence it appears that the mere presence of ferric oxide, except in a hydrated state and accompanied by free magnesia in quantity sufficient to neutralise the acids of the stomach, does not act as an antidote to arsenious acid. This case seems likewise to prove that arsenic taken in minute doses can accumulate in the system until it can be readily recognised in all organs, and can exert a dangerous action. The impunity with which the peasants of Styria consume small doses of arsenic would seem to depend upon circumstances not yet fully determined.

The "Apotheker Zeitung" gives the following formula for an ineradicable ink:—1·75 grms. aniline-black are ground up with 60 drops hydrochloric acid and 42 grms. alcohol, and the liquid is diluted with a hot solution of 2·5 grms. gum-arabic in 170 grms. water. If the aniline-black solution is diluted with a solution of 2·5 grms. shellac in 170 grms. spirit instead of gum-water, the result is an ink suitable for writing on wood, brass, or leather.

A letter from M. P. Truchot to M. Dumas concerning the apparatus of M. Lavoisier was read at a recent session of the Academy of Sciences. It appears that Lavoisier's chemical laboratory and physical cabinet have been reverently preserved by his family, and are now in the possession of M. E. de Chazelles, at Canière, near Aigueperse, Puy de Dome. The smallest of the three balances is sensitive to 1-612 grain. The weights belonging to these balances are wanting, but the kilogramme and its subdivisions as established by Fortin are present, recalling the fact that Lavoisier made all the determinations needful for fixing the weight of the kilogramme. There is a small model of an apparatus for the distillation of sea-water. There are a considerable number of precious stones, some of which have undergone the action of fire. Lavoisier is known to have made an experimental comparison of the heat produced by converging lenses with that of the blowpipe fed with oxygen.

With reference to the electric light superseding that obtained from coal-gas, Dr. Greiff contends, in "Die Chemische Indus-

trie," that even supposing the gas manufacture should ultimately be abandoned, the tar colours could be prepared from the residues left on rectifying the petroleum of the regions on the Caspian. These are estimated at 120 million kilos. yearly, and are ten times richer in benzol and five times richer in anthracen than is coal-tar. The American petroleum has not yet been examined from this point of view, but it will probably also prove to be a rich source of aromatic compounds.

Metallurgy, Mineralogy, Mining, &c.

In a Paper read at a Meeting of the Société de l'Industrie Minérale, M. Pourcel, after describing the rise and progress of the Thomas and Gilchrist method of dephosphorising iron, gives an interesting account of his visit to Messrs. Bolckow and Vaughan's works, at Eston, in May last, where the process was carried out in his presence. The method of working in no way differed from that described by Messrs. Thomas and Gilchrist, in their Paper read before the Iron and Steel Institute in May last. The prime conclusion which M. Pourcel draws from his investigations is that the dephosphorisation of iron in the Bessemer converter is an accomplished fact, and that the practical difficulties in the way of its industrial application may be surmounted by an attentive examination of the chemical phenomena which occur during the various operations.

A new application of rapid oxidation by which sulphides are utilised for fuel has been made by Mr. John Hollway, whose process has been fully described and discussed before the Society of Arts. This process has for its object the utilisation of the heat generated by the rapid oxidation of certain mineral substances which have not hitherto been used as sources of heat for smelting operations. The heat thus obtained is employed in the reduction of the furnace charge, which may be composed partly of sulphides and partly of silicious ores. A current of air is forced through molten sulphides, by which means they are very rapidly oxidised. Great heat is thus developed, rendering the process of smelting a self-supporting operation; therefore no extraneous fuel is required, excepting that employed in raising steam for the blowing engines; where, however, water power is available, steam can be dispensed with, in which case all the carbonaceous fuel necessary for the operation is a little coke to start the furnaces, which stands in the same relative position to the ores as wood does to coal in the lighting of an ordinary fire. The process may be defined as a system of fractional oxidation, in which the numerous constituents of a complex furnace charge can be separated from each other and concentrated in different parts of the apparatus, the heat necessary for the operation being obtained by the combustion of a portion of the less valuable constituents.

M. Galippe, in a paper read before the Biological Society of Paris, described the following experiment:—A rabbit received daily for six months a large dose of copper acetate. At the end of this time it was served up at the table of the learned chemist. The liver weighed 70 grms., and contained 13 centigrms. of copper. M. Galippe partook of it, and has suffered no inconvenience.

A new named metal, Norwegium, has been detected and isolated by Dr. Tellef Dahll in a sample of copper-nickel from Kragerö, in Skjærgaarden. The colour of the pure metal is white, with a slight brownish cast. When polished it has a perfectly metallic lustre, but after a time it becomes covered with a thin film of oxide. It can be flattened out in an agate mortar, and in hardness it resembles copper. The melting-point is 350° C., and the specific gravity 9·441. Its equivalent appears to be 145·9. Only one oxide, NgO, has been obtained. With sulphuretted hydrogen it gives a brown sulphide, even in strongly acid hydrochloric solutions, which re-dissolves in ammonium sulphide. With a slight addition of potassium ferrocyanide it gives a brown, but with larger proportions a green, precipitate. The sulphuric solution is turned brown on the addition of zinc, and the metal is deposited in a pulverulent state. The solutions of this metal are blue, but become greenish on dilution.

Two new phosphates, found at Skipton Caves, Victoria (N.S.W.), are described by Vom Rath in No. 79 of the "Bull. Soc. Min." (France). *Hannayite*—Triclinic, basal cleavage perfect; less perfect parallel to two prismatic planes; sp. grav., 1·893. Composition: phosphoric acid, 45·70 per cent; magnesia, 18·90; ammonia, 8·09; and water, 28·20 = 100·89 per cent. Loses, between 100° and 120°, 21·08 per cent water. *Newberyite*—Orthorhombic; cleavage brachydiagonal, perfect; basal, imperfect. Composition: phosphoric acid, 41·25; magnesia (by difference), 23·02; water, 35·73 = 100 per cent.

Huntilite, named after Dr. Sterry Hunt, occurs at the Silver Islet Mine, Lake Superior. According to the "Engineering and Mining Journal" it occurs in two varieties. The most abundant is amorphous, often porous; dark slate, grey, or almost black; dull. The crystalline variety is cleavable in one direction, and of a lighter slate-colour. The probable formula is $AsAg_3$.

The "Mineralogical Magazine" for July contains several interesting Papers, among which we may mention the following:—"Contributions towards a History of British Meteorites," by Townsend M. Hall; "Geognosy and Mineralogy of Scotland," "Preliminary Notice of Supposed New Scottish Minerals," and "On Haughtonite, a New Mica," by Prof. Heddle; "On some Gold Occurrences," by Rev. J. Clifton Ward; "Additional Note on Penwithite," "On Christophite from St. Agnes," and "On the 'Maxwell-Stuart' Topaz," by Mr. J. H. Collins; "On

Japanese Minerals," by Mr. John Milne; "Measurements of Angles of Basaltic Columns in Giant's Causeway," by Rev. J. H. Jellett.

According to the "Breslauer Zeitung" considerable deposits of sulphur are found in the gypsum formation of Upper Silesia, especially at Pschow and Kokoschütz, near Ratibor.

It appears from the Report of Prof. Burat on the Mine-Explosion at Frameries, given in "La Correspondance Scientifique," that more than 100,000 cubic metres of fire-damp must have been evolved in a very short time. All the two hundred safety-lamps (Mueseler's) were extinguished without causing ignition. The gas issuing from the shaft caught fire *outside* the mine (possibly from the engine furnace), and burnt with an enormous flame. When the supply was becoming exhausted the burning gas ran back into the interior of the mine, followed in its retreat by atmospheric air, and occasioned nine successive explosions. The whole occurrence is considered unexampled in the annals of coal-mining.

From the Reports of the Mining Surveyors and Registrars of Victoria we gather that the yield of gold for 1878 is estimated at 755,754 ounces, showing a decrease of 44,000 ounces as compared with 1877.

From a Paper on the Mineral Wealth of Turkey, in "Chemiker Zeitung," we learn that tin, cobalt, nickel, bismuth, and uranium are entirely absent. Chrome iron ore, emery, and copper are plentiful. Coal is found only in the basin of Eregli and Amastra on the Black Sea. There are numerous petroleum wells on the Persian frontier.

Referring to the grey modification of tin the same journal states that, according to Schertehl, tin, under certain unknown circumstances, becomes so brittle as to be crushed between the finger-nails, and has the sp. gr. 5·8. If boiled in water it recovers its ordinary colour and texture, while the sp. gr. rises to 7·3.

Chinese diamonds are, we are informed by the "Technologiste," chiefly brought from the province of Shantung. Men put on thick shoes of straw, and simply roam about the valleys and the rivers. The rough and pointed diamonds penetrate into the straw and stick fast. The shoes are finally collected together in heaps and burnt, when the diamonds remain in the ashes.

In a Paper on Amber M. Helm says that in entire fragments it is permeable to water. It contains as much as 4 per cent of sulphur in the state of organic combination. This sulphur has probably been absorbed by the fossil resin in the state of hydrogen sulphide subsequent to its formation. The author describes another fossil resin, gedanite, which differs from amber by containing a smaller proportion of oxygen, and is softer, more fusible, and more soluble in ether. It is free from succinic acid.